

12. A Revision of the Nematode Parasites of Elephants, with a description of four new species\*. By M. KHALIL, M.D., D.P.H., D.T.M. & H.†

(From the Helminthological Department of the London School of Tropical Medicine.)

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(Text-figures 1-71.)

Since Cobbold's admirable work on the parasites of the Indian elephant in 1882, our knowledge of the Helminths harboured by this species of elephant has been considerably enlarged by Lieut.-Col. C. Lane, Railliet & Henry, and others. Little advance has been made regarding the parasites of the African elephant. The new species recorded here, with one exception, are parasites of the latter animal.

The material upon which this study is based was collected by Prof. Leiper in Uganda as far back as 1909 from two elephants shot by him. In addition, specimens received from Dr. J. J. Simpson, West Africa, the Raymond Laboratories in India, and from Lieut.-Col. C. Lane, the latter's representing most of his type-species from the Indian elephant, were available for study and comparison. *Leiperenia galebi* was collected by Prof. Leiper from an Indian elephant that died in the London Zoological Society's Gardens.

Besides all this unique material, Prof. Leiper placed at my disposal his extremely valuable notes on the type-species in the Vienna and Berlin Natural History Museums. These proved to be of great assistance with regard to *Belascaris lonchoptera* Diesing, and *Murshidia linstowi*, sp. n.

I feel deeply indebted to Prof. Leiper for his unrestricted generosity and ever-ready help both as regards material and information, without either of which this work could not have been done.

The nematode parasites of the elephants are peculiar to these hosts, and it is an interesting fact that the parasites found in the African and Indian elephants never belong to the same species. *Grammocephalus clathratus*, which was formerly supposed to occur in both species of elephants, has lately been shown by Lane to be represented in the Indian elephant by a separate species. *Murshidia falcifera* is another example. In this paper it is shown that the African elephant harbours two species of *Murshidia*, one of which apparently was mistaken for *Murshidia falcifera*.

\* Communicated by Prof. R. T. LEIPER, D.Sc., M.D., F.Z.S.

† In a preliminary note published in the Ann. & Mag. Nat. Hist. for Feb. 1922, brief diagnoses were given of two new genera and seven new species which are here fully described and illustrated.

There is some confusion regarding the correct zoological terminology of the species of elephants. For this reason the terms African and Indian are used throughout this work.

## NEMATHELMINTHES.

### Class NEMATODA.

Super-family *RHABDIASOIDEA* Railliet, 1916.

Family *TRACTIDÆ* Travassos, 1919.

This family name was given by Travassos to include the following genera:—*Atractis*, *Ozolaimus*, *Rodonia*, *Labiduris*, *Crossocephalus*, *Macracis*, *Cobboldina*, and *Cyrtosomum*, to which I add the genus *Leiperenia*.

Travassos' diagnosis of the family runs as follows:—Œsophagus with an anterior and a posterior bulb; viviparous, the female genital system is generally single; vulva is placed posteriorly or in common with the anus; parasites of vertebrates.

### Genus *LEIPERENIA* Khalil, 1922.

Small nematodes just visible to the naked eye. The males are slightly smaller than the females. Mouth is surrounded by more than six lips. Œsophagus is divided into an anterior, short, and strongly muscular portion, to which the name pharynx is given. The posterior portion of the Œsophagus is about three times as long as the pharynx. The anterior end of the body is provided with a cuticular membranous expansion on either side. There is a large excretory vesicle. The excretory pore is raised on a papilla which is striated radially.

Male: The caudal extremity of the male is curved. There are two unequal spicules and an accessory piece. There are four papillæ on the tail.

Female: Viviparous, and the embryos reach an advanced stage of development *in utero*. The vulva is placed in the posterior part of the body, separate, and a short distance in front of the anus.

Type-species, *Leiperenia leiperi* (from the African elephant).

*LEIPERENIA LEIPERI* Khalil, 1922. (Text-figs. 1-4.)

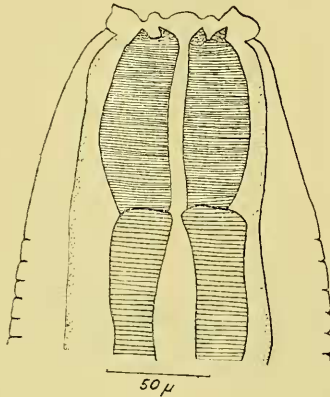
*Material*.—The material consists of two males and three females, taken from Prof. Leiper's collection of Elephant nematode parasites.

*Shape of body*.—These nematodes are very small and just visible to the naked eye. The males are 3.8 mm. long. The females are slightly longer, being 3.9 mm. in length. The maximum diameter of the body is about the middle: it is .2 mm. in the male and .21 mm. in the female. The body narrows slightly as it is traced towards the head end, which is truncated

in appearance. Posterior to the head a cuticular expansion is present on either side of the body. The female is practically straight; its tail is very long and is gradually attenuated to a fine point. The caudal end of the male is bent towards the ventral surface, and its end is more rounded than in the female.

*Skin.*—The cuticle is finely striated at intervals of  $\cdot 007$  mm. throughout the whole length of the body. The cuticular expansions near the cephalic end of the body are placed on both lateral sides, and extend from the level of the pharynx to practically the middle of the œsophagus. They are  $\cdot 3$  mm. in length and  $\cdot 037$  mm. maximum breadth, and are striated.

Text-figure 1.

*Leiperenia leiperi* Khalil. Cephalic end.

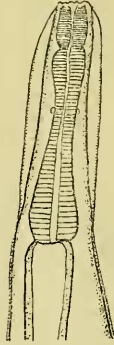
*Mouth collar.*—The mouth collar is very short and has a rounded shape. It is  $\cdot 012$  mm. long and  $\cdot 06$  mm. in diameter. The mouth-opening is practically circular and is surrounded by ten small lips. The lip in the mid-ventral line and that in the mid-dorsal line are the largest and broadest. The lips placed on either side of these lines are smaller and rounded. There is no mouth capsule.

*Pharynx.*—This is a short muscular canal. Its musculature is more closely set and of a finer texture than that in the succeeding œsophagus. It is also distinctly demarcated from it by a deep groove. For these reasons I named that specialized part of the œsophagus the pharynx. The shape of the pharynx is cylindrical, with a small bulging in the middle. It is  $\cdot 083$  mm. long and  $\cdot 06$  mm. maximum diameter. From its cephalic end project conical processes; their apices are directed antero-laterally. The number of these processes and their structure can only be ascertained under the oil immersion lens. They are eight in number surrounding the mouth-opening, and they are muscular

processes from the pharynx. The lumen of the pharynx is continuous with that of the œsophagus.

*Esophagus.*—The œsophagus is long and thin. In some specimens it pursues a wavy course. Its posterior end is a little swollen. It is .38 mm. long and .073 mm. maximum diameter.

Text-figure 2.



*Leiperenia leiperi* Khalil. Anterior part of the body.

*Chyle intestine.*—The intestine is irregularly bent in its course. Near its commencement its wall is surrounded by a clear refractile band, the nature of which is unknown. The cellular wall is slightly pigmented. The rectum is a short canal; in most cases its structure is obscured by the greatly distended genital organs of the female.

*Excretory system.*—The large excretory vesicle receives two excretory ducts, one from the lower part of the body and one from the head end. The excretory pore is wide and is placed .92 mm. from the cephalic end. It is placed on a raised papilla, striated radially round the pore.

*Nerve collar.*—The nerve collar surrounds the thinnest part of the œsophagus .22 mm. from the head end.

*Genital organs.*—Male: The irregularly convoluted testis reaches within .8 mm. from the head. The cement gland is long, and the ejaculatory duct opens into the ventral aspect of the cloaca.

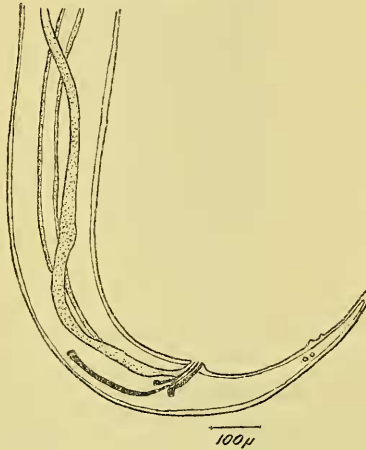
Female: In the mature female the genital tract is so distended with embryos that the details of this system are practically impossible to make out. By the help of an immature specimen the general features of the organs can be recognized. There is only one ovary and one uterus, placed in the axis of the body. The vagina is short, and opens in the posterior part of the body .1 mm. cephalad of the anus.

*Spicules.*—There are two unequal spicules and an accessory



piece. The longer spicule is  $\cdot 3$  mm. in length. It begins close to the dorsal surface, and lies parallel to it for about two-thirds of its course. Then it bends ventrally to pass into the cloacal canal anterior to the accessory piece. The shorter spicule is  $\cdot 19$  mm. in length. It lies by the side of the terminal portion of the longer spicule. Its thick cephalic end is bent ventrally, and is thus seen in the concavity of the longer spicule. The accessory piece is  $\cdot 09$  mm. long. Its cephalic extremity is large and rounded; its end is attenuated to a sharp point.

Text-figure 3.

*Leiperenia leiperi* Khalil. Caudal end of male.

*The tail.*—The male tail is curved, forming a semicircle. It is  $\cdot 38$  mm. long. Its extremity is rounded;  $\cdot 16$  mm. from the tip of the tail there are four papillæ. Two of these are placed near the mid-ventral line, one slightly caudal to the other. The other two are placed one on either side of the tail. These are all simple papillæ and project very little above the surface.

The female tail is very much longer and thinner than that of the male, being  $\cdot 7$  mm. in length; its termination is very fine. There are four papillæ on either side of the anus. No other papillæ could be detected on the female tail.

*The Embryos.*—The females are viviparous; the embryos reach an advanced stage of development while they are still in the uterus. Six embryos can be seen in the uterus at one time. They distend that organ enormously, and make identification of the neighbouring structures difficult, if not impossible. Some of these embryos measured  $\cdot 52$  mm. in length, and  $\cdot 06$  mm. in

diameter. The pharynx, œsophagus, and a straight gut can be easily recognized in them.

*Habitat.* The intestine of the African elephant (Uganda).

Text-figure 4.



*Leiperenia leiperi* Khalil. Tail end of female.

*LEIPERENIA GALEBI* Khalil, 1922. (Text-figs. 5-7.)

*Material.*—The material consisted of ten specimens collected by Prof. Leiper from an Indian elephant that died in the London Zoological Society's Gardens. They were the only Helminth parasites found in that elephant.

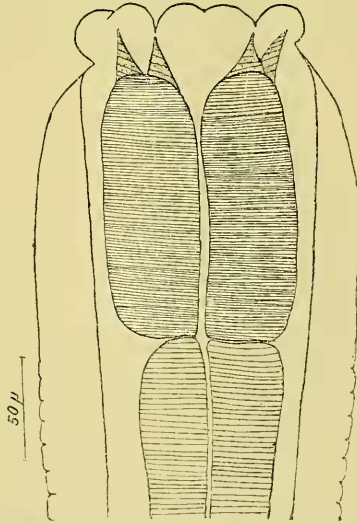
*Shape of body.*—These nematodes are just visible to the naked eye. The male is smaller than the female. It is 3.25 mm. long, while the female is 3.8 mm. The maximum diameter is attained near the middle of the body. It is .17 mm. in the male and .18 mm. in the female. The head end is truncated, while the caudal is attenuated to a fine end, more delicate in the female than in the male. The caudal end of the male is curved ventrally. The head end of the body has a lateral cuticular expansion on either side.

*Skin.*—The cuticle is striated throughout its length, except for a short distance at the cephalic extremity. The striations are at regular distances of .008 mm. apart. The cuticle is expanded in a membranous fashion on either side of the cephalic end of the body for a distance of .6 mm. It is striated in its greater extent, the part corresponding in level with the pharynx is not striated. The cuticular expansion is .023 mm. in breadth.

*Mouth collar.*—The mouth collar is distinctly separated from

the body by a groove. It is 0.18 mm. long and .08 mm. in diameter. It has a rounded margin. The oral opening is circular and is surrounded by ten rounded lips. The one in the mid-ventral line and also that in the mid-dorsal line are broader and divided into two by a superficial depression. There is no oral cavity.

Text-figure 5.

*Leiperenia galebi* Khalil. Cephalic end.

*Pharynx*.—The short cylindrical muscular pharynx is .14 mm. in length and .1 mm. maximum diameter. It is thus much longer and broader than in *L. leiperi*. From its cephalic end spring eight cone-shaped processes that surround the mouth-opening. The fine apices of these processes correspond more or less to the interlabial depressions.

*Œsophagus*.—The thin muscular œsophagus is irregularly bent. It is .39 mm. long in the male and .4 mm. in the female. Its maximum diameter is at posterior end, and measures in the male .06 mm. and in the female .07 mm.

*Chyle intestine*.—The intestine pursues an almost straight course. The cells of the intestinal wall are slightly pigmented. The short rectum is indistinctly marked from the intestine.

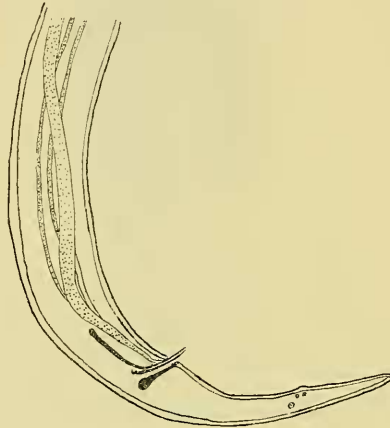
*Excretory system*.—There is a large excretory vesicle similar to that described in the type-species. The excretory pore is placed on a large raised papilla 1.2 mm. from the head end. The papilla is radially striated round the pore.

*Nerve collar.*—The small nerve collar surrounds the thinnest part of the œsophagus  $\cdot 25$  mm. from the head end.

*Genital organs.*—Male: The convoluted testis gives rise to the ejaculatory duct. This pierces the enormously elongated cement gland to end in the cloaca.

Female: The female is viviparous; the embryos reach an advanced stage of maturity, and so distend the uterus as to make the examination of other structures difficult. The convoluted ovary is single, and leads to the enormously dilated uterus. The short vagina opens on the surface of the body  $\cdot 06$  mm. in front of the anus. The convolutions of the ovary reach within  $\cdot 52$  mm. of the head end.

Text-figure 6.



*Leiperenia galebi* Khalil. Tail end of male.

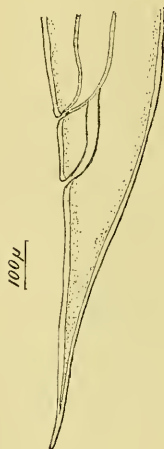
*Spicules.*—There are two unequal spicules and an accessory piece. The longer spicule is  $\cdot 25$  mm. long; thus it is shorter than that of the type-species. It lies in the axis of the body, midway between the ventral and dorsal surfaces. Near its lower end it bends boldly ventrally to pass into the cloaca. The shorter spicule is  $\cdot 13$  mm. long. It is very slightly curved, lying by the side of the terminal portion of the longer spicule. The accessory piece is  $\cdot 13$  mm. long. It has a thick bulbous end, and is gradually attenuated to end in a sharp point buried in the posterior lip of the cloacal opening. It lies practically across the axis of the body.

*The tail.*—The male tail is gracefully curved and is  $\cdot 43$  mm. in length. Its end is bluntly rounded. There are a group of four papillæ similar to those in *L. leiperi*. They are situated  $\cdot 17$  mm. from the tip of the tail. Two papillæ are in the middle line, one

slightly anterior to the other. Of the other two, one is placed on either side of the body at the same level.

The female tail is short and conical, unlike that of *L. leiperi*. Its tip is pointed. It is .53 mm. long. The anal opening is not raised or surrounded by prominent lips. On either side there are four papillae.

Text-figure 7.



*Leiperenia galebi* Khalil. Tail end of female.

*Embryos*.—The uterus is crowded with these giant embryos. They attain .48 mm. in length. The various parts of the digestive tract can be easily made out in them.

*Habitat*. Intestine of Indian elephant (India; died in the London Zoological Gardens).

#### Discussion.

This genus has some points in common with the genus *Atractis*. The latter was made by Dujardin to include *Ascaris dactyluris* of Rudolphi, 1819, but was not defined. The genus was defined by von Linstow in 1902. From von Linstow's description, together with a detailed account of the type-species by Railliet and Henry, *Leiperenia* can be easily separated by the following characters:—

In *Atractis* there are six lips surrounding the mouth. There are no cuticular membranous expansions in the anterior part of the body. The œsophagus is divided into two portions, of which the anterior is the longer. The number of the conical processes is limited to six. There is a cuticular expansion along the posterior two-thirds of the body. The species of *Atractis* are parasitic in Land and Freshwater Tortoises and Reptilia.

The two species of *Leiperenia* differ mainly in the length of the spicules and accessory piece, and particularly in the shape of the female tail, which is very long and narrow in *L. leiperi* and stumpy and broad in *L. galebi*.

Some of the genera included in the family Atractidæ are credited with the ability of reproduction and maturation in the same host. They are found in tremendous numbers in the host.

Super-family ASCAROIDEA Raill. & Henry, 1915.

Family ASCARIDÆ Cobbold, 1864.

Sub-family ASCARINÆ Travassos, 1913.

Genus BELASCARIS Leiper, 1907.

BELASCARIS LONCHOPTERA (Diesing, 1851) Leiper, 1911.

*Strongylus elephanti* Rud., 1819.

*Ascaris lonchoptera* Diesing, 1851.

*Belascaris lonchoptera* Leiper, 1911 (unpublished notes).

This was the first Helminth parasite recorded from the elephant. It was listed by Rudolphi in his 'Synopsis Entozoorum' under doubtful strongyles. The specimens were collected from the bile-ducts of an Indian elephant and deposited in the Museum of Vienna.

In 1847, Jackson recorded in the 'Descriptive Catalogue of Boston Medical Improvement Society' the presence of Ascaridæ and Flukes in the Indian elephant.

In 1851, Diesing described the doubtful specimens of Rudolphi, and found them to be female Ascaridæ and not Strongyles. He named them *Ascaris lonchoptera*. He also referred to the Ascaridæ of the Boston Catalogue as the same species.

In 1882, Cobbold expressed a doubt if such an illustrious man as Rudolphi would have mistaken an *Ascaris* for a Strongyle. In the same year Drasche redescribed and figured *A. lonchoptera* from the Vienna collection, and left no doubt as to its Ascarid nature, thus confirming Diesing's observations.

Leiper, in unpublished notes to which I have had access, records the results of his examination of the same specimens in the Vienna Museum, and concluded that they belonged to the genus *Belascaris* (Leiper, 1907).

Although a good deal of attention has been paid lately to the elephant parasites, especially in India, no Ascaridæ have been reported. So far, the male of *Belascaris lonchoptera* remains undescribed.

*Habitat.* Bile-ducts of the Indian elephant.



Super-family *SPIRUROIDEA* Raill. & Henry, 1915  
(emend. Hall, 1916).

Family *SPIRURIDÆ* Oerley, 1885.

Sub-family *SPIRURINÆ* Railliet, 1915.

Genus *PARABRONEMA* Baylis, 1921.

*Spiruridæ*: Polymyarian worms, having the mouth bordered by paired lateral lips, external to which there are a dorsal and a ventral shield of cuticle. Each lip has one large median lateral papilla and a pair of small sublateral papillæ. Of the dorsal and ventral shields, each carries a pair of larger papillæ, situated some distance behind the extremity of the head. The cuticle of the head is thick, and folded in a complicated manner so as to form a circlelet of six horseshoe-shaped auricular appendages, of which two are lateral, two subventral, and two subdorsal.

The body is rather slender, tapering rather more in front than behind. The cuticle is transversely striated. The buccal cavity a short distance from the oral aperture is transversely elongated, then passes into a long cylindrical cuticular tube. The œsophagus consists of a short, narrow anterior portion and a long, somewhat wider posterior portion. The anterior portion is surrounded by the nerve-ring.

The tail of the male is coiled ventrally into a spiral. The spicules are markedly unequal. A somewhat triangular accessory piece is present. There are six pairs of papillæ, four pre-anal and two post-anal. There is also a large median double papilla immediately in front of the cloacal opening.

The female is considerably larger than the male. The tail is short and curved towards the dorsal side. The vulva is in the region of the end of the œsophagus. The vagina is long and narrow. It has a curious U-shaped bend in its course, a short distance from the vulva. The two uteri are parallel, running backwards at first, one of them returning towards the anterior end of the body. The female is viviparous. The uterus contains immense numbers of embryos.

Type-species, *Parabronema indicum*.

*PARABRONEMA INDICUM* Baylis, 1921.

The male is 7.9 mm. and the female is 13 mm. in length. The vulva is situated a little caudad of the end of the œsophagus. The longer spicule of the male is 0.93 mm. long and the shorter is 0.39 mm. The tail of the male is 0.17 mm. and that of the female is 0.32 mm. in length.

*Habitat.* Stomach-wall of the Indian elephant (India).

PARABRONEMA AFRICANA Baylis, 1921.

This species was apparently mistaken by Baird for female *Grammocephalus clathratus*. It was isolated and described from the original material by Baylis in 1921, but Leiper in his notes in 1911 recorded and drew this species from material in the Berlin Museum, where it was kept under the name *Ascaris lonchoptera*. He recognized this mistake in diagnosis, and added that the same species is included wrongly by Baird in his type of *G. clathratus* in the Natural History Museum of London.

The male is 40 mm. and the female is 57 mm. in length. The lips have a median inward projection on their opposed edges. Vulva is placed just caudad or cephalad of the end of the oesophagus. The left spicule is 3.15 mm. long and the right is 0.68 mm. The male tail is 0.85 mm. and the female tail is 0.52 mm. in length.

*Habitat.* Stomach-wall of the African elephant (died in London).

PARABRONEMA SMITHII Cobbold, 1882. (Text-figs. 8-12.)

*Filaria smithii* Cobbold, 1882 (not *Filaria smithi* Sambon, 1907, from the Grouse *Lagopus scoticus*).

*Spiroptera smithi* Raill., Henry & Bauche, 1914.

*Parabronema smithi* Baylis, 1921.

*Source of Material.*—The material consisted of one male and three females sent from the Raymond Laboratories, Calcutta. They were collected from an Indian elephant.

*Shape of body.*—Very small nematodes. The females much larger than the males. The male is 4.1 mm. long and the female 8 mm. The maximum diameter of the body is about the middle of the worm, being 0.2 mm. in the male and 0.26 mm. in the female. The female is always curved, the tail directed dorsally. The tail of the male is spirally coiled ventrally.

*Skin.*—The cuticle is very finely striated throughout the length of the body.

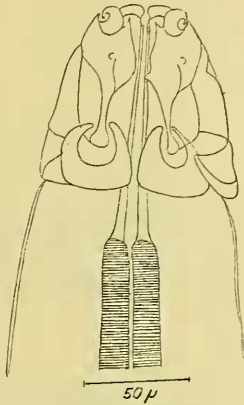
*The head.*—The cuticle surrounding the head end is raised from the surface of the body, forming a complicated design. Its caudal margin surrounds the circumference of the body 0.083 mm. from the head end. It forms six auricular appendages, two lateral, two subventral, and two subdorsal. Each auricle is open towards the head. Their posterior margin is nearly flat, unlike the rounded appearance in *P. indicum* or the angular appearance in *P. africana*. Each of the two lateral lips bears three papillæ, a large one near the centre and two smaller ones near the margin on either side. The cuticular shields lower down bear four papillæ. The terminal extremity of the head is 0.03 mm. in diameter.

*Cervical papillæ.*—The cervical papillæ are placed 0.209 mm. from the head end.

*Digestive system.*—There is a buccal cavity just behind the oral

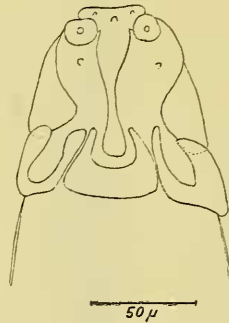
aperture. This leads into a long cuticular tube leading into the œsophagus. The length of that part of the digestive system is  $\cdot 1$  mm. The œsophagus consists of two portions. The cephalic part is thin and practically straight. It is  $0\cdot 14$  mm. long in the male and  $0\cdot 16$  mm. in the female. This portion is surrounded by the nerve collar. The caudal part of the œsophagus is very long and broad in diameter. It pursues a crooked course, being acutely bent from side to side. It is  $1\cdot 06$  mm. long in the male and  $1\cdot 09$  in the female. Its caudal end projects into the intestine and is protected by a trilobed valve.

Text-figure 8.



*Parabronema smithii* Cobbold.  
Ventral view of head.

Text-figure 9.



*Parabronema smithii* Cobbold.  
Lateral view of head.

*Chyle intestine.*—The intestine pursues a straight course and is lightly pigmented. The rectum is narrow and is constricted from the rest of the intestine.

*Excretory pore.*—This could only be made out in the female, where it is  $0\cdot 25$  mm. from the head end.

*Nerve collar.*—The thick nerve collar surrounds the cephalic portion of the œsophagus. It is placed  $0\cdot 22$  mm. from the head end in the male and  $0\cdot 23$  mm. in the female.

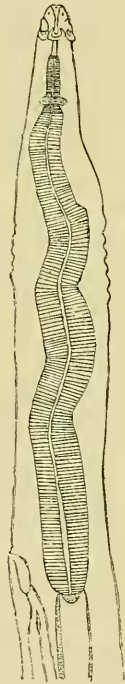
*Genital organs.*—Male: The coils of the convoluted testes lie more in the longitudinal axis of the body. The long cement gland curves in the caudal end of the body to end in the ventral aspect of the cloaca.

Female: The vulva lies a little cephalad of the end of the œsophagus in the mid-ventral line. At a distance of  $0\cdot 1$  mm. from the vulval opening, the caudally directed vagina produces a distinct U-shaped kink, and then resumes its course caudally, where it is directly joined by the two uteri. The uteri proceed

caudally. They are packed with embryos and no signs of eggs. The ovaries are confined mostly to the caudal half of the body.

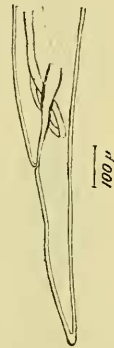
*Spicules*.—There are two unequal spicules. The long spicule is 0.56 mm. long. It lies to the left of the short spicule, which is 0.21 mm. long. The latter lies parallel with the lower end of the long spicule, and curves ventrally towards the cloacal opening. There is a small triangular accessory piece 0.03 mm. in length.

Text-figure 10.



*Parabronema smithii* Cobbold.  
Anterior part of the body.

Text-figure 11.



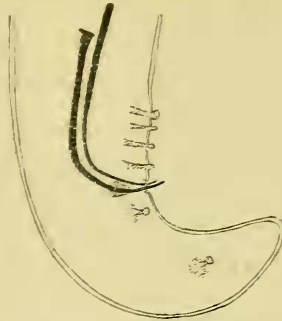
*Parabronema smithii* Cobbold.  
Female tail.

*Caudal papillæ*.—The male tail is provided with four pairs of pre-anal papillæ lying on either side of the mid-ventral line. Each is provided with a long core and a single termination. Two pairs of post-anal papillæ could be made out, one close to the cloaca and the other midway between the cloaca and the tip of the tail.

*Tail*.—The male tail is spirally coiled ventrally. It is shorter than that of the female and its tip is rounded. It is 0.18 mm. in length.

The female tail is slightly bent dorsally. It narrows gradually to its tip, which is slightly rounded. There is apparently no papillæ on the female tail. The length of the tail is 0.36 mm.

Text-figure 12.

*Parabronema smithii* Cobbold. Male tail.

*Embryos*.—The female is viviparous. The embryos are so closely packed that it was impossible to arrive at an approximate estimate of their length.

*Habitat*. Coats of the stomach of the Indian elephant (India).

#### Discussion.

Baylis described fully *P. indicum* and *P. africana*. He was not able to find material containing *P. smithii*, which has only been alluded to once since it was described by Cobbold. There has been some doubt as to the identity of *P. indicum* and *P. smithii*, as Cobbold's description was not full. For this reason the latter species is described here in full. It is certainly a different species from *P. indicum*, although found in the same host. It is a much smaller worm, and the measurements of its various organs are likewise shorter than the corresponding figures of *P. indicum*.

The shape of the auricular appendages is different from that alluded to above. The African species is of very great length, and its auricular appendages of the cuticular thickening of the head are quite distinctive. All its other dimensions are correspondingly longer than in the other species.

#### MICROFILARIA.

Evans and Rennie record the presence of a microfilaria in blood taken from an elephant during the daytime. It measured 180  $\mu$  in length and 6  $\mu$  in breadth. It is possible that it was really a microfilaria, but I suggest that it is more probable that the

viviparous species of *Parabronema* living in the stomach-wall void their embryos into the lymphatics or blood and not into the intestinal canal.

Super-family *STRONGYLOIDEA* Wienland, 1858.

Family *STRONGYLIDÆ* Cobbold, 1864.

Sub-family *STRONGYLINÆ* Railliet, 1893.

Genus *DECRUSIA* Lane, 1914.

Fairly stout worms with a cup-shaped mouth capsule. There is a marked duct of the dorsal œsophageal gland running along the mid-dorsal line of the mouth capsule.

Male: The dorsal ray is undivided except at its extreme tip. The spicules are equal and similar, fine-pointed, and without accessory piece.

Female: The tail is blunt, the vulva is in the caudal third, the uteri are divergent, the caudad-running uterus turning immediately cephalad.

Type-species, *Decrusia additictia*.

*DECRUSIA ADDITICTIA* Raill., Henry & Bauche, 1914.

*Strongylus additictus* Raill., Henry & Bauche, 1914.

*Decrusia decrusi* Lane, 1914.

*Decrusia additictia* Raill., Henry & Bauche, 1915.

*Decrusia additictia* Lane, 1915.

*Strongylus additictus* Ihle, 1919.

This species has the characteristics of the genus. The mouth capsule is tilted dorsally. The external leaf-crown consists of 140-150 rays. Male is 14 mm. long and 1.0 mm. maximum diameter. The spicules are 2.4 mm. long. Female is 15 mm. long and 1.4 mm. maximum diameter. The tail is 0.3 mm. long, blunt at the tip. The vulva is 7.3 mm. from the tip of the tail. The ova are  $75\mu$  long by  $40\mu$  broad.

Ihle thinks that this genus is an unjustifiable division of the genus *Strongylus*. Although there are points of similarity between the two genera, the dorsal tilt of the mouth-opening, the long dorsal ray of the bursa, and the absence of an accessory piece make this genus justifiable. In the genus *Strongylus* itself, it was suggested by Looss that *S. vulgaris*, which is more allied to *S. equinus* the type-species than *Decrusia additictia*, might eventually prove to belong to another genus.

*Habitat.* Large intestines of the Indian elephant (India).

Genus *MURSHIDIA* Lane, 1914.

Lane's diagnosis of the genus runs as follows:—"Fairly slender worms tapering towards the head end. The male is widest just



cephalad of the bursa, the female tapers caudad to a fine point. The head is discoid in shape. The oral aperture is bounded by two slightly marked lateral lips, each carrying a sessile lateral and two prominent submedian papillæ. The oral capsule is roughly cylindrical, and circular in cross-section, while the wall varies in shape in different parts. Since this is thicker caudad and thinner cephalad on its dorsal and ventral than on its lateral aspects, its cavity is, at its cephalad end, wider dorso-ventrad than latero-laterad. The cuticle bounding the mouth cavity is applied to the mouth capsule only over its caudad portion. Along a circumferential line, which is further cephalad on the dorsal and ventral than on the lateral walls, the cuticle turns axo-cephalad and splits into rays having a similar direction; and since further these rays are shorter dorsally and ventrally than laterally, the result is that their points which form the boundary of the oral aperture, do not describe a circle but produce a dorso-ventral slit. The œsophagus is fairly short, widening caudad of the nerve-collar. Its caudal end is guarded by three intestinal valves. The boundaries of the cells of the chyle intestine are more marked than usual. The cephalic and the cervical glands are large and well developed. The lateral cervical papillæ are long, slender, and project somewhat cephalad.

"The male expands ventrad just cephalad of the bursa. The number of bursal rays is as usual. The externo-dorsal rays lie close to the lateral rays. The dorsal ray is deeply cleft in the mid-line, and each half is composed of three subdivisions. There appear to be no pre-bursal papillæ. The spicules are equal and similar, and the head of each is bent like the head of a golf-driver, while the shaft may be straight or may be bent near the point. There is a colourless thickening of the cuticle in the position of the accessory piece, which is S-shaped in lateral optical section. The other male organs are as usual.

"The female has a long and pointed tail, the vulva lying shortly cephalad of the anus. The vagina runs cephalad and divides into two uteri, which have the same direction, and are provided with ojectors, run parallel with one another, and end abruptly in the two cephalad-running ovaries."

I may add to this that an accessory piece is present, and although the male is broad just above the bursa, this is not always the greatest diameter of the body.

Type-species, *Murshidia murshida*.

MURSHIDIA MURSHIDA Lane, 1914.

This nematode has the general characteristics of the genus. The external leaf-crown consists of sixty leaflets. The vulva has a cuticular prominence both cephalad and caudad of it. (For measurements *vide* Table I., p. 228.) The lateral and dorsal rays of the bursa have a rugged outline and a bulbous origin.

*Habitat.* Cæcum of Indian elephant (India).

MURSHIDIA FALCIFERA Cobbold, 1882.

*Strongylus falcifer* Cobbold, 1882.

Nematode No. 3. Evans & Rennie, 1910.

*Strongylus falcifer* Mitter, 1912.

*Cylicostomum falciferum* Raillet, Henry & Bauche, 1914.

*Murshidia falcifera* Lane, 1914.

The oral aperture is bounded by eighty rays. The bursal rays have not the rugged outline seen in *M. murshida*. (For measurements see Table I.)

Mitter in 1912 gave a short description of this nematode with figures. He represented the bursa with one ray missing, which is either the externo-dorsal or one of the terminal branches of the dorsal ray. In either case this may be attributed to inaccuracy.

*Habitat.* Intestine of Indian elephant (India).

MURSHIDIA LINSTOWI, sp. n. (Text-figs. 13 & 14.)

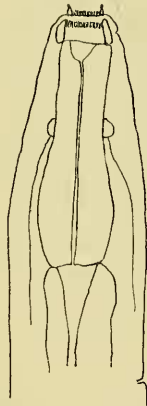
*Sclerostomum rectum* von Linstow, 1907, from the African elephant (not *Strongylus rectus* von Linstow, 1906, from *Dolichotis patagonica*).

*Cylicostomum rectum* Gedoelst, 1916.

*Murshidia recta* Ihle, 1919.

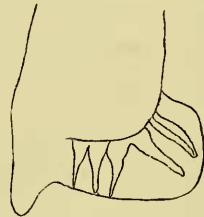
This species was first described by von Linstow in 1907 as *Sclerostomum rectum*. The genus *Sclerostomum* Rudolphi, 1809,

Text-figure 13.



*Murshidia linstowi*, sp. n.  
Cephalic end of body.

Text-figure 14.



*Murshidia linstowi*, sp. n.  
Lateral view of male bursa.

By kind permission of Prof. Leiper.

is a synonym of *Strongylus* Goeze, 1782, both having as their type-species *S. equinus* Mueller, 1780. Thus *Strongylus* has

precedence. Von Linstow described in 1906 *Strongylus rectus* from *Dolichotis patagonica*.

According to Article 36 of the International Law of Zoological Nomenclature, the specific name *rectum*, 1907, must be rejected and can never be used again.

This is in complete agreement with the views expressed by Lane. He rightly was unable to arrive at the conclusion that the nematode described by von Linstow belongs to the genus *Murshidia*, because the original description and figures are very unsatisfactory. Only the figure of the male bursa shows any marked resemblance to *Murshidia*.

I have been fortunate in having access to a series of camera-lucida drawings of von Linstow's original material in Berlin Natural History Museum, made by Prof. Leiper and very generously placed at my disposal. Unfortunately, the exact magnification was not noted, and therefore von Linstow's measurements are relied upon, as they correspond in proportion to the camera-lucida drawings.

The mouth capsule is wide, surrounded by a chitinous ring of the shape characteristic of the genus. The œsophagus is short and thick. The excretory pore is placed a considerable distance caudad of the œsophagus. The vulva is surrounded by raised cuticle, specially cephalad. The male bursa is short and the lateral rays are not rugged in outline. The spicules are straight and sharply bent near their terminations, which are bulbous in shape. (For details of measurements see Table I.)

*Habitat.* From the African elephant (Cameroon).

MURSHIDIA HADIA Khalil, 1922. (Text-figs. 15-21.)

*Material.*—The material consisted of one male and four females, selected from Prof. Leiper's collection of Elephant nematodes.

*Shape of body.*—The body of the male is straight, the female tail is slightly bent ventrally. The male is 18.5 mm. long and the female is 24 mm. long. The maximum diameter of both sexes is about the middle, being .67 mm. in the male and .82 mm. in the female. The antero-posterior diameter of the male body just cephalad of the bursa is .55 mm. This is a little smaller than the diameter at the middle of the body.

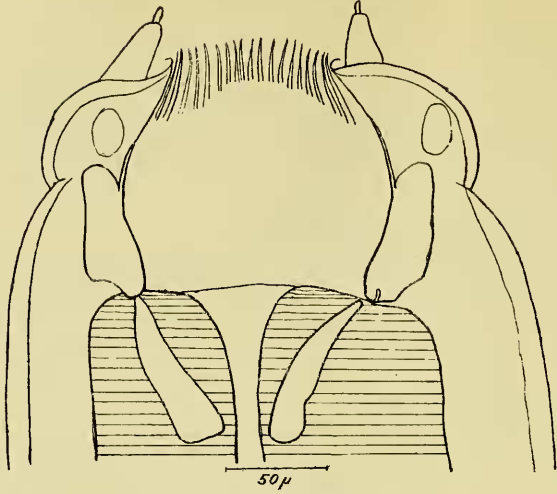
*Skin.*—The cuticle is finely striated at intervals of .009 mm.

*Mouth collar.*—This is well developed and rounded in outline. It is .05 mm. long and .2 mm. in diameter. It is distinctly separated from the rest of the body by a deep groove.

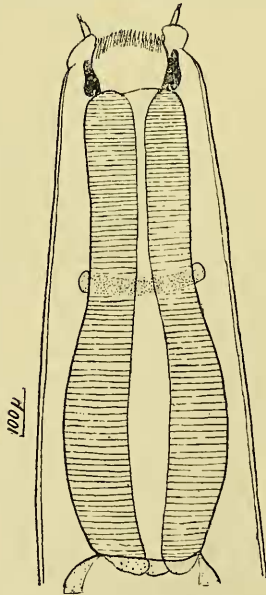
*External leaf-crown.*—Arising from the inner surface of the mouth collar is the external leaf-crown, consisting of forty rays. These rays are longer laterally than ventrally or dorsally. Each ray is narrow and gradually tapers to a point.

*Head papillæ.*—There are the usual four submedian head papillæ. They project freely above the head. Each is surmounted by a small knob which, as already mentioned, represents

Text-figure 15.

*Murshidia hadia* Khalil. Head.

Text-figure 16.

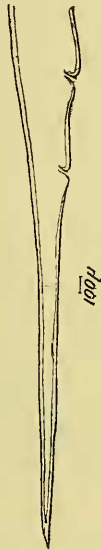
*Murshidia hadia* Khalil. Cephalic end of body.

the outlet of the cephalic glands. The two lateral head papillæ do not project above the surface, and are marked by a slight depression. They are conical in shape with a wide base.

*Cervical papillæ*.—The cervical papillæ are very thin, long, and point cephalad. They are placed 1·4 mm. in the female and 1·14 mm. in the male from the head end.

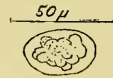
*Mouth capsule*.—The mouth cavity is very large and almost globular in shape. It is ·12 mm. long and ·15 mm. maximum diameter. The oral opening is ·07 in diameter. The mouth capsule is a massive chitinous structure ·07 mm. in length and ·025 mm. in thickness. It is slightly curved inwards. A fine chitinous process of the mouth capsule bounds the oral cavity in the region of the mouth collar. The broad floor of the oral cavity is free from any teeth.

Text-figure 17.



*Murshidia hadia* Khalil.  
Tail end of female.

Text-figure 18.



*Murshidia hadia* Khalil.  
Ovum.

*Œsophagus*.—There is a cone-shaped œsophageal funnel. It is ·06 mm. in length and ·1 mm. at its junction with the oral cavity. The œsophagus is broad for its length. It is ·85 mm. long in the male and ·9 mm. in the female. Its maximum diameter is ·26 mm. in the male and ·34 mm. in the female. The caudal end of the œsophagus projects into the beginning of the chyle intestine, forming three small lobules.

*Chyle intestine.*—The intestine takes a practically straight course in the axis of the body. The wall of the intestine is annulated on the external surface by shallow depressions between the cells. Except for a short distance at the beginning and end the whole length of the gut-wall is deeply pigmented. The rectum is an elongated and narrow canal indefinitely demarcated from the intestine.

*Excretory pore.*—The excretory pore is placed just caudad of the nerve-ring in the mid-ventral line. It is .068 mm. from the head end.

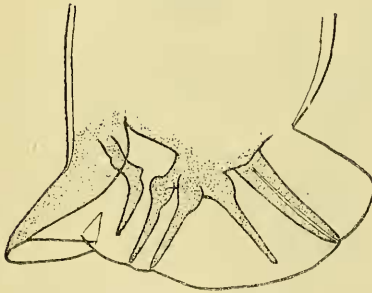
*Nerve collar.*—This is very thin in comparison with the size of the worm. It is placed .6 mm. from the cephalic end.

*Genital organs.*—Male: The testis is irregularly coiled, reaching within 5 mm. of the head. There is no distinct seminal vesicle. The cement gland is of enormous length.

Female: The wide opening of the vulva is surrounded by a raised cuticular margin. The strongly muscular vagina runs straight towards the head end. The two uteri are convergent, ending in strong ovejectors lying side by side and joining the cephalic end of the vagina. The ovaries are irregularly coiled, reaching within 5 mm. of the head end.

*Bursa.*—The bursa is very short, and indistinctly divided into three lobes of approximately the same length. It measures .22 mm. in length and .7 mm. in breadth.

Text-figure 19.



*Murshidia hadia* Khalil.  
Lateral view of bursa.

Text-figure 20.



*Murshidia hadia* Khalil.  
Dorsal ray of bursa.

The ventral ray is bifid throughout its length, and is placed a considerable distance from the ventral edge of the bursa. The lateral rays arise by a common origin. At the site of their bifurcation each ray has a bulb-like swelling. The externo-lateral ray lies separate from the other two and close and parallel to the ventral ray. It ends in a papilla on the external surface a short distance from the edge of the bursa. The medio-lateral and dorso-lateral rays lie close together. The externo-dorsal ray has



a rugged outline. It arises in common with the dorsal ray, and lies close to and parallel with the postero-lateral ray, ending a short distance from the edge of the bursa on the external surface. The dorsal ray arises by a very broad origin and bifurcates into two branches, each ending in three rays. The outer two rays arise by a common trunk and lie close together. The medial ray is stouter and longer, and ends some distance from the corresponding ray of the opposite side. The dorsal ray is .25 mm. long.

*Genital cone.*—The genital cone ends in a sharp point. The cloacal canal opens a little distance posterior to the apex.

*Spicules.*—The two similar spicules are very stout and practically straight. The club-shaped tip is bent sharply forwards. They are 1.1 mm. in length. There is a small, curved accessory piece .1 mm. in length. The cephalic portion of the spicular sheath is reticulated.

Text-figure 21.



*Murshidia hadia* Khalil. Spicules and accessory piece.

*Termination of the female.*—The female tail gradually tapers to a sharp point. It is 2.25 mm. long. The vulva is placed .6 mm. cephalad of the anus.

*Ova.*—The ova in the vagina are small: 40  $\mu$  long and 23  $\mu$  broad. They are then in the morula stage of development.

*Habitat.* Intestine of the African elephant (Uganda).

*Discussion.*

The main specific differences between the members of the genus *Murshidia* are to be found in the shape of the rays of the male bursa, the length of the spicules, the length of the female tail, and the distance between the vagina and the anus. These and other differences are for convenience tabulated below.

Upon these data the species *Murshidia linstowi* was differentiated.

Railliet, Henry and Bauche have recorded the presence of *Murshidia falcifera* in the African elephant. This was probably either *M. hadia* or *linstowi*, which bear a superficial resemblance to *M. falcifera*.

In the following table all measurements given are in millimetres. The measurements of *M. murshida* and *M. falcifera* are based partly on Lane's record and partly on material of both species sent by him to Prof. Leiper. These specimens are labelled by Lane as type material of the respective species. The measurements of *M. linstowi* are based on the original record of this species by von Linstow. Where the sex is not stated, the measurements are put in the centre of the column.

TABLE I.

	<i>M. murshida</i> .		<i>M. falcifera</i> .		<i>M. linstowi</i> , sp. n.		<i>M. hadia</i> .	
	♂. India.	♀.	♂. India.	♀.	♂. Africa.	♀.	♂. Africa.	♀.
Total length .....	mm. 18-20	mm. 22-28	mm. 22-25	mm. 28-30	mm. 25	mm. 29	mm. 18.5	mm. 24
Maximum diameter .....	.6	.9	.74	1.05	.97	1.1	.67	.82
(Esophagus .....	.5	.52	.88	.55	.97	.8	.85	.9
Nerve collar .....	.3	.31	.48	.52	.....	.....	.6	.6
Diameter of head .....	.17		.23		.....		.2	
Rays of leaf-crown .....	60		80		.....		40	
Diam. of mouth capsule .....	.08		.1		.....		.15	
Length of spicules .....	1.28		1.55		.96		1.1	
Tail of female .....	1.6		2.1		3.1		2.25	
Vulva from tail end .....	2.3		2.9		4.3		2.85	
Ova .....	.....		.05 × .03		.052 × .024		.04 × .023	
Cuticular striation .....	.007		.007		.01		.009	
Cervical papillæ .....	.85		1.2		.....		1.14 1.4	
Excretory pore .....	.8		1.05		.....		.68	

Genus *CHONIANGIUM* Raill., Henry & Bauche, 1914.

*Asifa* Lane, 1914.

Fairly stout, straight worms; the head is obliquely truncated dorsad. The oral opening is directed towards the dorsal surface.

The oral aperture is surrounded by a circle of converging rays. The mouth capsule is large and like a funnel in shape. Rounded cuticular prominences protrude into the oral cavity.

Male: The most striking feature of the bursa is an accessory ray projecting from the dorsal aspect of the main stem of the lateral ray. The two spicules are similar and equal. There is an accessory piece. Railliet wrongly recorded that the dorsal ray divides into four branches instead of three.

Female: The vulva is close to the anus, where the worm suddenly narrows. The tail is bluntly conical.

Type-species, *Choniangium epistomum*.

CHONIANGIUM EPISTOMUM Piaua & Stazzi, 1900.

*Sclerostomum epistomum* Piaua & Stazzi, 1900.

*Choniangium epistomum* Raill., Henry & Bauche, 1914.

*Asifia vasifa* Lane, 1914.

The male measures 14 mm. in length, with a maximum diameter near the head of 0.75 mm. The spicules are 2.0 mm. in length.

The female is 19 mm. in length, with a maximum diameter of 1.0 mm. The vagina runs cephalad, joining the two parallel uteri. The ova measure  $50\ \mu$  by  $25\ \mu$ .

*Habitat.* Cæcum of the Indian elephant (India).

Genus QUILONIA Lane, 1914.

*Evansia* Railliet, Henry & Joyeux, 1913 (not *Evansia* Scott, 1906, for a copepod).

*Quilonia* Lane, 1914.

*Nematevansia* Ihle, 1919.

*Quilonia* Ihle, 1919.

Fairly slender worms; the head discoid, the mouth terminal and surrounded by two sessile lateral and four prominent submedian papillæ. The rays of the external leaf-crown are few and characteristically curved. The cuticular lining of the oral cavity does not lie directly in contact with the chitinous mouth capsule. The mouth-opening is narrower than the diameter of the oral cavity. The œsophagus is nearly cylindrical in shape. Two or more teeth project into the oral cavity.

Male: The bursa is more or less distinctly divided into three lobes. The dorsal lobe is longer than the lateral lobes. The bursal rays are the usual number. The dorsal ray is bifurcate, each branch having three subdivisions. The spicules are equal and similar, and each has a sickle-shaped point. The accessory piece is curved from side to side, the concavity being ventrad. Seen from the dorsum it is wider cephalad than caudad.

Female: The vulva is in the caudal third of the body. The uteri are opposed, divergent and furnished with marked ovejectors. The caudad uterus turns cephalad immediately beyond its ovejector. The two uteri run cephalad side by side. Brown

cement on the vulva is fairly marked. The ova are colourless and thin-shelled and have a granular yolk.

Type-species, *Quilonia renniei*.

QUILONIA RENNIEI Raill., Henry & Joy., 1913.

Nematode No. 2 from Indian elephant. Evans & Rennie, 1910.

*Evansia renniei* Raill., Henry & Joy., 1913.

*Quilonia quilona* Lane, 1914.

*Evansia renniei* Lane, 1915.

*Nematevansia renniei* Ihle, 1919.

*Quilonia renniei* Ihle, 1919.

The main features of this species, as described by Evans and Rennie and also by Lane, are: (a) the leaf-crown projects freely above the head, (b) the leaflets are thin and long, (c) the dorsal ray bifurcates low down in the bursa, and (d) its tri-radiate final branches are very thin and arise at different levels. (For measurements see Table II.)

*Habitat.* Cæcum of the Indian elephant (India).

QUILONIA TRANVACRA Lane, 1914.

*Quilonia tranvacra* Lane, 1914.

*Evansia tranvacra* Raill., Henry & Bauche, 1915.

*Nematevansia tranvacra* Ihle, 1919.

*Quilonia tranvacra* Lane, 1921.

The leaf-crown does not project above the head. It consists of ten rays. The branches of the dorsal ray are stouter and longer than in *Q. renniei*. (For measurements see Table II., p. 249.)

*Habitat.* Cæcum? of the Indian elephant (India).

QUILONIA APIENSIS Gedoelst, 1916. (Text-figs. 22-28.)

*Evansia apiensis* Gedoelst, 1916.

*Quilonia apiensis* Lane, 1921.

This parasite was recorded by Gedoelst unaccompanied by figures. In the genus *Quilonia* it is extremely difficult to differentiate species on description only. Lane, in describing *Q. africana*, expressed his regret that *Q. apiensis* was recorded without figures. The same difficulty was experienced in examining the material at my disposal without a full knowledge of *Q. apiensis*. Later, Prof. Gedoelst very generously sent co-type material of his species to be added to Prof. Leiper's collection. This made possible a complete description of the species with camera-lucida drawings.

*Material.*—The material consisted of 25 specimens labelled *Quilonia apiensis* (co-types) from Prof. Gedoelst. Of these, eight specimens are kept in the Helminthological collection of the London School of Tropical Medicine. In addition, three specimens were identified by me in Prof. Leiper's material.

*Shape of body.*—The body is straight, slender, and tapering towards either end. The male is 16 mm. long and the female is

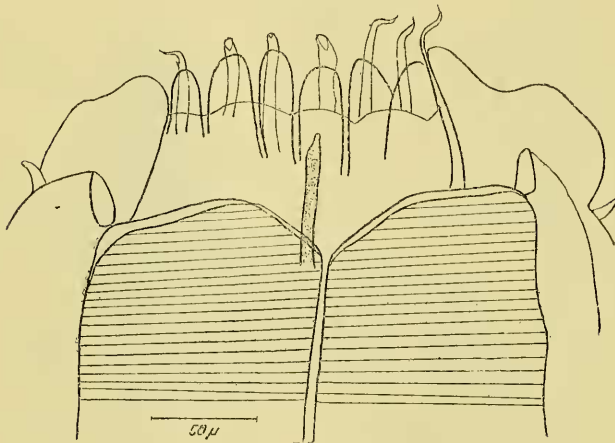
19–21 mm. long. The maximum diameter of the body is about the middle. It is .62 mm. in the male and .78 in the female.

The average length of this species given here is greater than that originally recorded. Gedoelst stated that the length of the male is 12.8 mm. and the female 17.8 mm. That these measurements were based on a single individual male and one female is evident from his remarks: "L'unique exemplaire que nous avons étudié mesurait, etc." The measurements recorded here are the average of all the specimens available.

*Skin.*—The cuticle is striated at regular intervals of .02 mm.

*Mouth collar.*—The mouth collar is distinctly separated from the rest of the body by a groove. There is a curious cuticular prolongation in the form of a spine at the site of this groove

Text-figure 22.



*Quilonia apiensis* Gedoelst. Lateral view of head.

The mouth collar is irregularly rounded in outline, being .04 mm. in length in the male and .08 in the female. It is .16 in diameter.

*External leaf-crown.*—This consists of twelve leaflets. These are thin and curved at the top, ending in a fine point. They project freely above the head.

*Head papillae.*—The four submedian head papillae are thick. Each is surmounted by a knob-like structure. The two lateral papillae are thin and do not project above the surface. Their termination is marked by a depression.

*Cervical papillae.*—The two cervical papillae are thin and point slightly cephalad. They are placed on the lateral lines .98 mm. from the head end in the male and 1.04 mm. in the female.

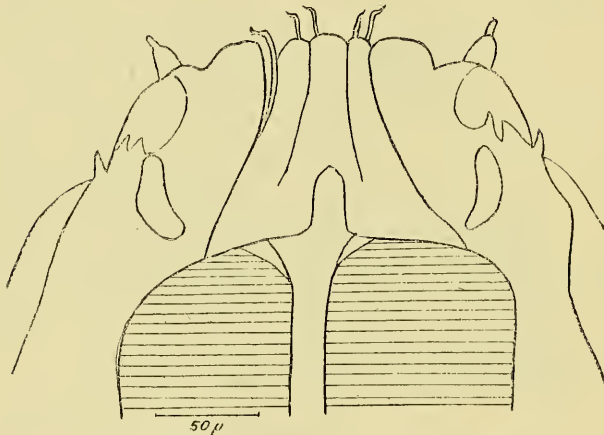
*Mouth capsule.*—The chitinous mouth capsule is a short ring .04 mm. in length and .16 mm. in diameter. It is not in

contact with the wall of the oral cavity. The oral cavity is wide laterally and contracted from before backwards. It is cone-shaped.

*Internal leaf-crown.*—This consists of twelve leaflets corresponding to the external leaf-crown. Each is broad, with a rounded blunt end and does not project above the mouth collar.

*Oesophagus.*—There is a small but distinct oesophageal funnel having a chitinous wall. From the top of the oesophageal columns two spinous processes project into the mouth capsule. These are not so prominent as in *Q. africana*. The oesophagus is .73 mm. long in the male and .8 mm. in the female. It is .25 mm. in maximum diameter in the male and .28 mm. in the female.

Text-figure 23.



*Quilonia apiensis* Geddoelst. Dorsal view of head.

The oesophagus is slightly narrowed at the site of the nerve collar. The caudal end of the oesophagus projects into the beginning of the intestine, forming a tri-lobed valve.

*Chyle intestine.*—The intestine is straight and thick-walled. It is deeply pigmented in its middle two-thirds. In most specimens there is a characteristic constriction in the outline of the intestine 2 mm. from its caudal end.

*Rectum.*—A marked groove indicates the beginning of the rectum. Its walls are thin and chitinous. The lumen is spindle-shaped, .42 mm. in length.

*Excretory system.*—The excretory vesicle is small and has a delicate wall. The excretory pore is placed .6 mm. from the head end.

*Nervous system.*—The nerve collar surrounds the narrowest



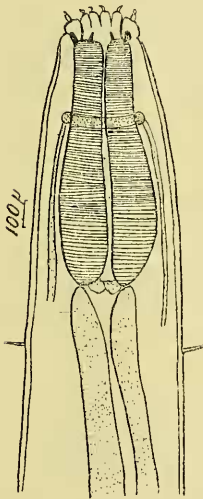
part of the œsophagus and is .24 mm. from the head end. Two long bands stretch from the nerve collar caudally.

*Genital organs.*—Male: The fine tubules of the testis are bent irregularly, reaching to within 4 mm. of the head end. There is no distinct vesicula seminalis. The cement gland is of enormous length, ending in the anterior part of the genital cone.

Female: The two convoluted ovaries reach within 5 mm. of the head end. The two uteri lie side by side in the longitudinal axis of the body. Each ends in a strong ovejector—that of the anterior uterus is cephalad and that of the posterior uterus is caudad of the vagina. The two ducts from the muscular part of

Text-figure 25.

Text-figure 24.

*Quilonia apiensis* Godoelst.

Ventral view of anterior portion of body.

*Quilonia apiensis* Gedoelst.

Female tail.

the ovejector join a very short vagina placed transversely to the longitudinal axis of the body. The vulva is not surrounded by raised lips. It is situated 6.2 mm. from the tip of the tail. brownish cement surrounds the vulval opening.

*Bursa.*—The bursa is more or less divided into three lobes. The posterior lobe is slightly longer than the lateral lobes. Seen from the lateral aspect, it resembles somewhat the bursa of *Q. uganda* in shape, although the dorsal ray is totally different. The bifid ventral ray lies close to the lateral rays. The fissure

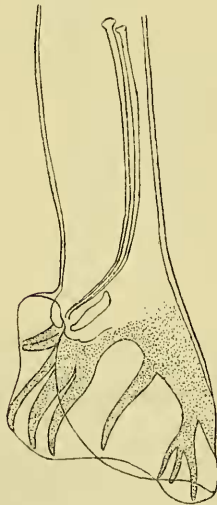
between the medio-lateral and the postero-lateral rays is deeper than that between the medio-lateral and the ventro-lateral rays. The externo-dorsal ray arises from the stem of the dorsal ray. The dorsal ray is .7 mm. long. It bifurcates in its lower third. Each branch after a short course divides

Text-figure 26.

*Quilonia apiensis* Gedoelst. Ovum.

into three rays at the same level. In many specimens, however, the lateral two branches tend to lie close together, and the fissure between them is not so deep as that which separates the medial branch.

Text-figure 27.

*Quilonia apiensis* Gedoelst.  
Lateral view of bursa.

Text-figure 28.

*Quilonia apiensis* Gedoelst.  
Dorsal ray of bursa.

*Genital cone.*—The genital cone is blunt at the apex, which lies in line with the ventral surface of the body. The cloacal canal opens posterior to the apex and is surrounded by four rounded lips.

*Spicules.*—The two similar spicules are gracefully curved ventrally. Their tips are fine and bent dorsally. They are .91 mm. in length. The accessory piece is .19 mm. in length. It is concave ventrally, providing a canal for the spicules. It is thicker at its cephalic than at its caudal end.

*Termination of female.*—The tail of the female is rather broad. The tip in most specimens is diseased and deeply pigmented, but a few retain the tip, which is fine. The tail is 2.66 mm. in length. The anal opening is slightly raised above the surface.

*Ova.*—The ova in the vagina are thin-shelled, measuring 88  $\mu$  by 48  $\mu$ . They contain a morula.

*Habitat.* Intestine of African elephant (Belgian Congo and Uganda).

#### QUILONIA AFRICANA Lane, 1921.

This species is represented by more specimens than any other in the Uganda material. It agrees in all characters with Lane's description, except in the length of the female tail and the distance of the vulva from the anus. These were given by Lane as 4 mm. the length of the tail, and 4 mm. the distance of the vulva from the anus. On re-examining Lane's type-species, kept in the Natural History Museum, I could not find a single specimen with these measurements. All correspond to my previously taken measurements, being 3.6 mm. length of tail, and 3.25 mm. distance of vulva from the anus. Lieut.-Col. Lane ascribes this to the fact that the proofs of his paper were not corrected by him. (For detailed measurements based on my observation, see Table II.)

*Habitat.* Stomach of African elephant (South Africa and Uganda).

#### QUILONIA UGANDA Khalil, 1922. (Text-figs. 29-34.)

*Material.*—The material consisted of fifteen specimens sorted from the Uganda collection.

*Shape of the body.*—The body is short and straight. The female is slightly longer and thicker than the male. The male is 11.5-12 mm. long and the female is 16 mm. long. The maximum diameter of the body is about the middle. It is .55 mm. in the male and .64 mm. in the female.

*Skin.*—The cuticle is striated more closely near the head end than in the middle of the body. Near the head the intervals between each two striations is .01 mm., near the middle of the body it is .02 mm.

*Mouth collar.*—The mouth collar is distinctly separated from the body by a groove. It is rounded in outline, .04 mm. in length and .19 mm. in diameter.

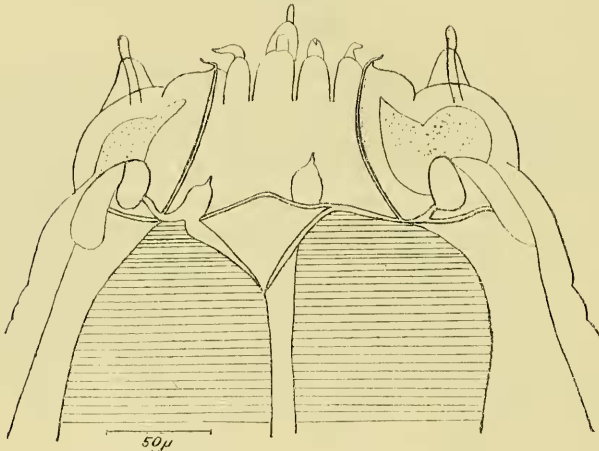
*Anterior leaf-crown.*—From the inner surface of the mouth collar projects the anterior leaf-crown. It consists of twelve

leaflets, fairly broad and bent characteristically at their tips. They project a little distance above the head.

*Head papillæ.*—The four submedian head papillæ project a little above the mouth collar. They point straight forwards. Their bases are broad and each is surmounted by a long knob, the function of which is pointed out elsewhere. The two lateral head papillæ do not project, and their termination is marked by a depression.

*Cervical papillæ.*—The two delicate cervical papillæ are placed a little posterior to the level of the caudal end of the œsophagus. They are  $\cdot78$  mm. from the head in the female and  $\cdot61$  mm. in the male.

Text-figure 29.



*Quilonia nganda* Khalil. Head.

*Mouth capsule.*—The chitinous mouth capsule is  $\cdot15$  mm. in diameter. It is oval in optical cross-section and is not in contact with the wall of the oral cavity. The oral cavity is shallow and funnel-shaped. It is  $\cdot06$  mm. deep and  $\cdot11$  mm. diameter at its floor. The mouth-opening is  $\cdot07$  mm. in diameter. From the floor of the oral cavity project two large chitinous oval teeth, each surmounted by a delicate sharp spine. These are placed on the cephalic end of the two sub-ventral œsophageal columns.

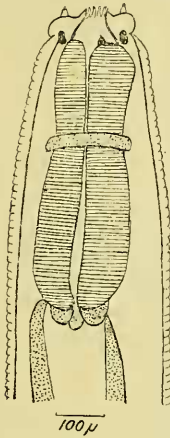
*Internal leaf-crown.*—The short stumpy leaflets of the internal leaf-crown correspond in number to the external crown. They have a rounded end and do not project above the surface.

*œsophagus.*—There is a shallow œsophageal funnel surrounded by a chitinous rim. The œsophagus is short and thick, being  $\cdot52$  mm. in length in the male and  $\cdot62$  mm. in the female. Its maximum diameter is  $\cdot2$  mm. and  $\cdot21$  mm. in the respective sexes. The end of the œsophagus projects into the chyle intestine, its opening being guarded by a trilobed valve.

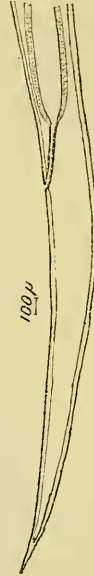
*Chyle intestine*.—The course of the chyle intestine is straight in the axis of the body. The intestinal wall is thick and deeply pigmented in its caudal half. The rectum is a narrow, long canal .28 mm. in length, demarcated from the intestine by a groove round the circumference of the gut.

Text-figure 31.

Text-figure 30.



*Quilonia uganda* Khalil.  
Cephalic end of body.



*Quilonia uganda* Khalil.  
Female tail.

Text-figure 32.



*Quilonia uganda* Khalil. Ovum.

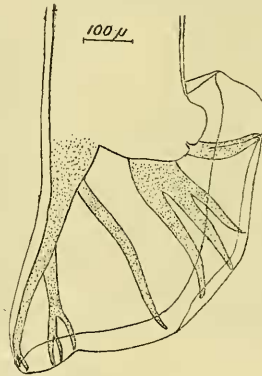
*Nerve collar*.—The thick nerve collar is placed .25 mm. from the cephalic end. It surrounds the narrowest part of the cesophagus.

*Excretory pore.*—The excretory pore is .47 mm. from the head end.

*Genital organs.*—Male: The convoluted testis reaches within 3 mm. of the head end and is irregularly coiled. The vesicula seminalis is spindle-shaped, lying in the long axis of the body. The cement gland is very long, measuring 3.5 mm.

Female: The irregularly convoluted ovaries reach within 3 mm. of the head. The divergent two uteri lie side by side for most of their course. Each ends in a strong muscular ovejector which lies, in the case of the anterior uterus, cephalad and, in the case of the posterior uterus, caudad of the vagina. The latter is a short horizontal duct joining both uteri to the vulva. The opening of the vulva is not surrounded by raised lips, and is placed 2.17 mm. cephalad of the anus.

Text-figure 33.



*Quilonia uganda* Khalil. Lateral view of bursa.

*Bursa.*—Seen from the lateral aspect the bursa has a spindle shape, lying obliquely to the longitudinal axis of the body. The dorsal lobe is slightly longer than the lateral lobes and has a rounded end. The ventral, lateral and externo-dorsal rays conform to the general design in the genus, but are all more slender. The dorsal ray is long and thin, being .5 mm. in length. It bifurcates in its lower third into two long and slender branches. These in their turn branch nearer their ends. The most lateral ray arises first, and the two medial rays arise by a common trunk branching lower still. This arrangement is exactly the opposite of that in *Q. apiensis*.

<sup>10/6</sup> The pre-bursal papillæ are placed .52 mm. from the tip of the bursa.

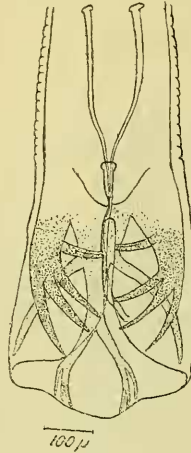
*Genital cone.*—This cone is placed nearer the ventral than the dorsal surface. Its tip is rounded. The cloacal opening is



marked by a depression in its outline a little distance dorsal to the apex.

*Spicules*.—The two similar spicules are .72 mm. long, the shortest in all the members of the genus. The tips of the spicules are sharp and bent ventrally. The elongated accessory piece is .1 mm. in length. It is curved ventrally to lodge the spicules.

Text-figure 34.



*Quilonia uganda* Khalil. Ventral view of bursa and spicules.

*Termination of female*.—The female tail is 2.43 mm. in length. It ends in a fine point. The anal opening is marked by a round depression from the surface.

*Ova*.—The ova seen in the terminal part of the uterus are thin-shelled. Their contents are in the morula stage. The dimensions of the ova are  $60\ \mu$  in length by  $30\ \mu$  in breadth.

*Habitat*. Intestine of African elephant (Uganda).

*QUILONIA BREVICAUDA*, sp. n. (Text-figs. 35-39.)

*Material*.—The material consisted of two specimens sorted out from the Uganda collection of nematode parasites of the elephant.

*Shape of the body*.—The female is much stouter and longer than the male. The outstanding feature of this species, as its name implies, is the short tail of the female ending bluntly, as can be seen with the naked eye. The male bursa is very much smaller than in the other species. The male is 13 mm. long. The female is 21 mm. long. The maximum diameter

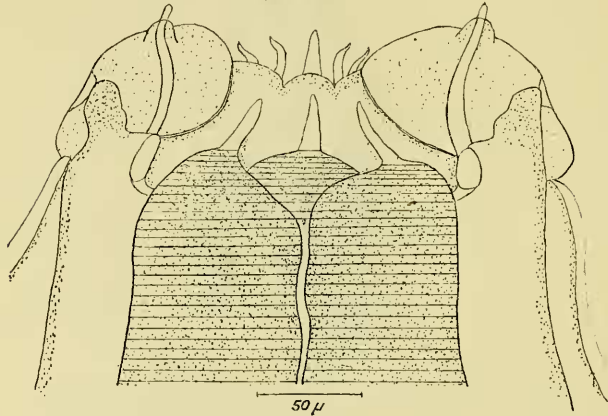
of the body in either sex is about the middle. It is .45 mm. in the male and .85 mm. in the female.

*Skin*.—The cuticle is striated at intervals of .02 mm. throughout the length of the body.

*Mouth collar*.—The mouth collar is rounded in outline. It is .06 mm. long in the male and .08 mm. in the female. Its diameter is .18 mm. in the male and .22 mm. in the female.

*External leaf-crown*.—This consists of ten very slender leaflets, bent near their termination. They do not project freely above the head.

Text-figure 35.



*Quilonia brevicaula*, sp. n. Head.

*Head papillae*.—There are the usual four submedian head papillae. These are stumpy and surmounted by a knob each. The lateral head papillae do not project above the surface and are marked with a depression.

*Cervical papillae*.—The two cervical papillae are very thin and directed slightly cephalad. They are .95 mm. from the head end in the male and 1.1 mm. in the female.

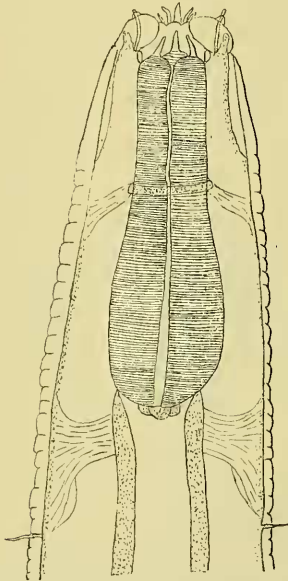
*Mouth capsule*.—The chitinous mouth capsule is very short. It has a diameter of .13 mm. in the male and .14 mm. in the female. It lies closer to the oral cavity than in the other species. The oral cavity is funnel-shaped, narrowing towards the mouth-opening. Into the mouth capsule project three formidable long teeth; each is placed on the top of one of the three oesophageal columns. This peculiarity is apparently limited to this species.

*Internal leaf-crown*.—This consists of blunt and slightly projecting processes placed deep in the oral capsule.

*Œsophagus*.—There is a small œsophageal funnel. The œsophagus is elongated, being .52 mm. in length in the male and .7 mm. in the female. It is slightly constricted in the region of the nerve collar. From its posterior end project the three lobes of the œsophageal valves.

*Chyle intestine*.—The chyle intestine pursues a straight course. It is pigmented in its middle. The rectum is sharply demarcated from the end of the intestine. It is narrow and thin-walled, and measures .24 mm. in length.

Text-figure 36.

*Quilonia brevicauda*, sp. n. Cephalic end of body.

*Excretory pore*.—This is situated in the mid-ventral line .73 mm. from the head end in the male and .88 in the female.

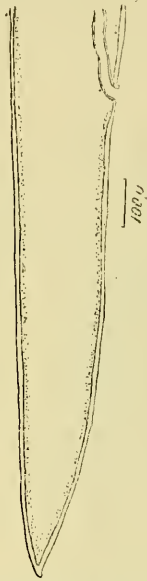
*Nerve collar*.—The nerve collar surrounds the œsophagus .29 mm. from the head end in the male and .39 mm. in the female.

*Genital organs*.—Male: The convoluted testis reaches within 3 mm. of the head end. There is no distinct seminal vesicle. The cement gland is very long.

Female: The convoluted ovaries reach within 6 mm. of the head end. The two divergent uteri lie side by side for the most of their course. Each ends in a strong muscular ovejector. That

of the posterior uterus makes a loop caudad of the vulval opening before joining the ovejector of the anterior uterus to form the very short horizontal vagina. The vulva is covered with dark brown cement. It is 5.1 mm. from the tail end and 3.35 mm. from the anus.

Text-figure 37.



*Quilonia brevicauda*, sp. n.  
Female tail.

Text-figure 38.



*Quilonia brevicauda*, sp. n.  
Ovum.

*Bursa*.—The male bursa is short and broad. It is .63 mm. in length and .52 mm. in breadth. The ventral, lateral and externo-dorsal rays are similarly arranged as in other members of the genus. The dorsal ray is short and broad. It is .5 mm. in length. It divides in its lower third into two thick branches. Each in turn ends in three small and thick rays. The most lateral arises separately and at higher level. The middle ray is the shortest.

*Genital cone*.—The blunt genital cone hardly protrudes into the bursa. The cloacal opening lies a little dorsal to its blunt apex.

*Spicules*.—The two similar spicules are .81 mm. in length. Their termination is very fine and directed ventrally. The accessory piece is .19 mm. in length. Its lateral margins curve forwards, forming the dorsal wall of the cloacal duct.

*Termination of the female.*—This forms the most characteristic feature of this species. The female tail is broad and short. It is 1.75 mm. in length. It is of practically uniform diameter till near the tip, where it is cone-shaped. The tip is blunt.

Text-figure 39.

*Quilonia brevicauda*, sp. n. Bursa and spicules.

*Ova.*—The ova seen in the terminal portion of the uterus contain a morula. They measure  $56\ \mu$  in length and  $33\ \mu$  in breadth.

*Habitat.* Intestine of African elephant (Uganda).

QUILONIA ETHIOPICA, sp. n. (Text-figs. 40–45.)

*Material.*—The material consisted of eight specimens sorted from the Uganda collection.

*Shape of body.*—The body is straight, broader near the middle, and gradually tapering towards either end. Male is 13.5 mm. long and .55 mm. maximum diameter. The female is 19 mm. in length and .7 mm. maximum diameter.

*Skin.*—The cuticle is finely striated through the whole body except for a short distance caudad of the head. The striations are at intervals of .029 mm.

*Mouth collar.*—The mouth collar is rounded in outline. It is

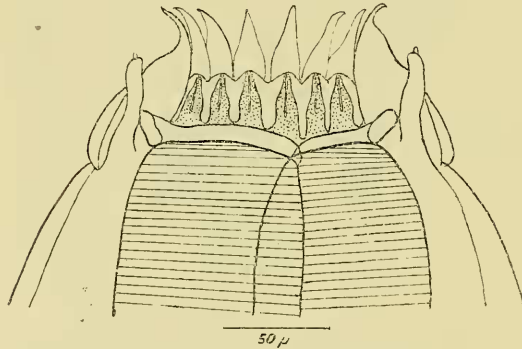
·06 mm. in length in the male, ·08 mm. in the female. The diameter is ·14 mm. in both sexes.

*External leaf-crown.*—The external leaf-crown consists of twelve leaflets. These are the most prominent characteristic of the species in their appearance and arrangement. They are broad, leaf-like, and slightly bent at the tip. They do not protrude above the head.

*Head papillæ.*—The four submedian head papillæ are displaced laterally by the external leaf-crown. They project directly forwards, and each is surmounted by a small papilla, the nature of which is referred to elsewhere. The lateral papillæ do not project, and their termination is marked by a depression.

*Cervical papillæ.*—The two laterally placed cervical papillæ are directed slightly cephalad. They lie ·7 mm. from the head end in the male and ·86 mm. in the female.

Text-figure 40.



*Quilonia ethiopica*, sp. n. Head.

*Mouth capsule.*—The chitinous mouth capsule is extremely shallow. In optical cross-section it lies oblique to the axis of the body. It is ·018 mm. in depth and ·12 mm. in diameter. The chitinous mouth capsule does not come in contact with the wall of the oral cavity. The latter is practically cylindrical in shape and slightly contracted in the middle. There are apparently no teeth projecting into the mouth cavity.

*Internal leaf-crown.*—The twelve leaflets of the internal leaf-crown can be traced from the floor of the mouth cavity to about its middle. Each leaflet is broad at its base and tapers to a point. It has a distinct cleft in the middle, and thus each is really two leaflets side by side.

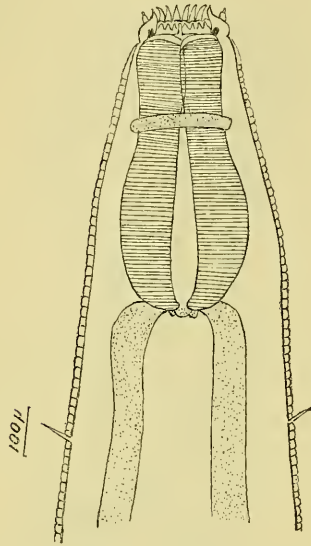
*Œsophagus.*—There is a shallow œsophageal funnel surrounded by a chitinous rim lying on the three œsophageal columns. The œsophagus is short and thick. It is ·55 mm. in length in the male and ·57 mm. in the female. It is slightly narrowed at the



site of the nerve collar. Its maximum diameter is  $\cdot 21$  mm. in the male and  $\cdot 26$  mm. in the female. The posterior end of the oesophagus projects into the intestine, and its opening is guarded by a trilobed valve.

*Chyle intestine.*—The straight chyle intestine is pigmented in

Text-figure 41.



*Quilonia ethiopica*, sp. n. Cephalic portion of body.

its middle third. The narrow rectum is  $\cdot 23$  mm. in length and sharply demarcated from the rest of the intestine.

*Excretory pore.*—The excretory pore lies in the mid-ventral line  $\cdot 6$  mm. from the head end.

Text-figure 42.



*Quilonia ethiopica*, sp. n. Ovum.

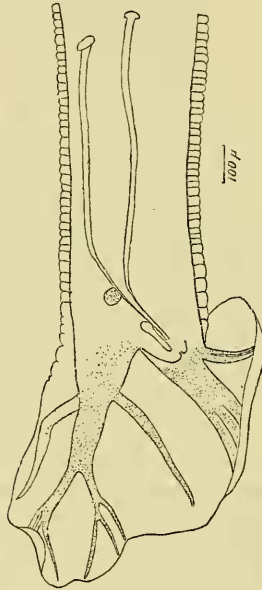
*Nerve collar.*—The nerve collar is  $\cdot 25$  mm. from the head end.

*Genital organs.* Male: The testis is convoluted irregularly, reaching within  $3\cdot 5$  mm. of the head. There is a peculiarly

shaped seminal vesicle, having the form of two spindles connected with a narrow duct. The cement gland is long and pierced by the long ejaculatory duct, which opens into the ventral aspect of the cloaca.

Female: The convoluted ovaries reach within 4 mm. of the head end. The divergent uteri lie side by side for most of their course. Each is provided with a well-developed muscular ovejector. The posterior ovejector loops caudad of the vulvar opening before joining the anterior ovejector to form the short horizontally placed vagina. The vulva is covered with brown cement and lies 4.97 mm. from the tail end.

Text-figure 43.



*Quilonia ethiopica*, sp. n. Male bursa and spicules.

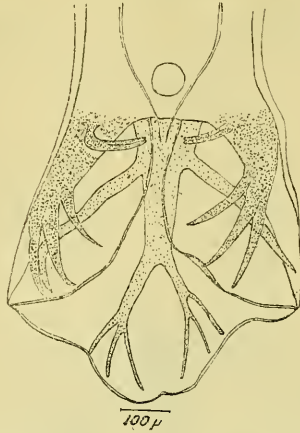
*Bursa.* The male bursa conforms to the usual type. The dorsal lobe is slightly longer than the lateral lobes. The bursa is .8 mm. in length and .6 mm. in breadth. The ventral, lateral and externo-dorsal rays are arranged in a similar fashion, as seen in the other species. The dorsal ray is .67 mm. in length. It bifurcates in its lower third. The terminal branches are slender and long. The lateral branch separates first.

*Genital cone.*—The genital cone is fairly long and pointed. The cloacal opening lies near its apex.

*Pre-bursal papilla.*—These lie on the lateral lines .75 mm. from the end of the bursa.

*Spicules*.—The two similar spicules are .83 mm. in length. They end in a fine termination, bent forwards. The accessory

Text-figure 44.



*Quilonia ethiopica*, sp. n. Ventral view of bursa.

Text-figure 45.



*Quilonia ethiopica*, sp. n. Female tail.

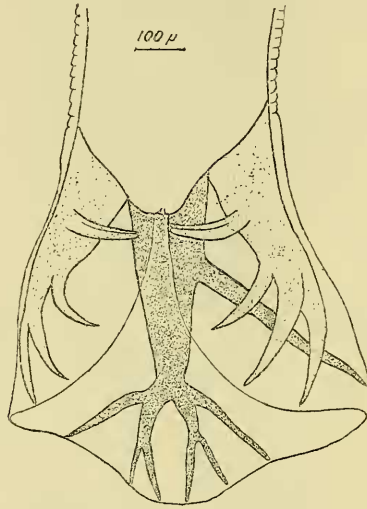
piece is .1 mm. long. It has a bulbous cephalic extremity. It is grooved ventrally to lodge the spicules.

*Termination of the female.*—The female tail is 2.3 mm. long. It tapers gradually. Its tip is rounded.

*Ova.*—The ova in the terminal part of the uterus are oval in shape, thin-shelled, and contain a morula. They measure  $63\ \mu$  long and  $35\ \mu$  broad.

*Habitat.* Intestine of African elephant (Uganda).

Text-figure 46.



*Quilonia africana* Lane. Abnormality in the rays of the bursa.

In a male specimen of *Q. africana* which was otherwise normal, the externo-dorsal ray was completely missing on one side, as is shown in the accompanying camera-lucida drawing. This abnormality must be very rare, and has apparently not been recorded before.

#### Discussion.

As was mentioned before, the identification of any particular species of the genus *Quilonia* from descriptions only is very difficult. Diagrams representing the head and tail ends are necessary. *Q. brevicauda* is easily distinguished on account of its short stumpy tail. For the rest, careful comparison is necessary for diagnosis. The important features in this connection are the shape of the head, the external leaf-crown, the dorsal ray of the male bursa, the length of the spicules, the length of female tail, and the distance between the vulva and anus.

The fact that the external leaf-crown may or may not project above the head divides the genus into two groups. In *Q. renniei*,

TABLE II.—Measurements of species of the genus *Quilonia* Lane, 1914.

	<i>Q. remiei</i> .		<i>Q. transvaca</i> .		<i>Q. apiensis</i> .		<i>Q. africana</i> .		<i>Q. uganda</i> .		<i>Q. brevicauda</i> .		<i>Q. ethiopia</i> .	
	♂.	♀.	♂.	♀.	♂.	♀.	♂.	♀.	♂.	♀.	♂.	♀.	♂.	♀.
Total length .....	15	20	18	20	16	19-21	15	21	11.5	16	13	21	13.5	19
Maximum diameter .....	.6	.85	.65	.9	.62	.78	.52	.64	.55	.64	.45	.87	.55	.7
Diam. of mouth collar .....	.2			.26	.22	.27	.18		.19		.18	.22		.17
External leaf-crown .....	18 rays.		10 rays.		12 rays.		12 rays.		12 rays.		10 rays.		12 rays.	
Length of oral cavity .....	.1		.18		.06	.08	.1		.06		.04		.01	
Diam. of mouth capsule .....	.16		.17		.16		.15		.15		.13	.14	.12	
Length of oesophagus .....	.8		.75		.73	.8	.68	.79	.52	.62	.52	.7	.55	.57
Max. diam. " .....	.25		.2		.25	.28	.2	.23	.2		.18	.2	.21	.26
Cervical papillae .....	.85		1.0		.98	1.04	.92	.95	.61	.78	.95	1.1	.7	.86
Excretory pore .....	.65		.....		.78	.82	.6	.92	.47		.73	.88		.6
Nerve collar .....	.4		.45		.....	.34	.43	.52	.25		.29	.39		.25
Spicules .....	.825		.9		.91		.9		.72		.81			.83
Accessory piece .....	.175		.2		.19		.16		.1		.19			.1
Female tail .....	2.0		2.3		2.66		3.6		2.43		1.75			2.3
Vulva from tail end .....	6.0		5.8		6.2		6.85		5.2		5.1			4.97
Cuticular striation .....	.031		.037		.02		.025		.02		.02			.029
Ova .....	75-81.5 μ	by 37.5 μ	70 μ	by 45 μ	83 μ	by 48 μ	73 μ	by 30 μ	65 μ	by 30 μ	56 μ	by 83 μ	63 μ	by 35 μ

*apiensis*, *uganda*, and *ethiopica* the external leaf-crown projects. In *Q. ethiopica* particularly the shape of its leaflets is so distinctive as to form a specific difference. In *Q. tranvacra*, *africana*, and *brevicauda* the external leaf-crown is more or less hidden by the mouth collar.

Table II. gives in detail the various measurements useful in differentiating any species of *Quilonia*. The data for *Quilonia renniei* and *tranvacra* are taken from Lane. The data for the rest of the species are based on my personal examinations. The numbers are given in millimetres.

#### Genus PTERIDOPHARYNX Lane, 1921.

Body is slender, with discoidal head. The rays of the external leaf-crown vary in length. The oral cavity has the shape of an inverted funnel, its cuticular lining coming into contact with the circular chitinous ring which forms the oral capsule. The oesophagus is short and wide. The internal aspect of the three oesophageal columns may or may not be sculptured in a plumose fashion. When this is present, the free internal surface of the oesophagus is moulded into a number of freely projecting ridges which run obliquely outwards and posteriorly, giving it a feathered appearance.

In the male bursa the lateral ray has a prominence or accessory ray on its posterior border, while of the three branches of each dorsal ray the two outer are fused partly or to nearly their tips. The spicules are equal and similar, and an accessory piece is present.

The vulva lies closely anterior to the anus, the vagina running anteriorly and dividing into two parallel anteriorly directed uteri, each provided with an ovejector.

Type-species, *Pteridopharynx africana* Lane, 1921.

#### PTERIDOPHARYNX AFRICANA Lane, 1921.

Very little needs to be added to the description given by Lane. The leaflets of the external leaf-crown are sixteen in number. There are two teeth projecting into the floor of the mouth capsule, apparently regarded by Lane as the beginning of an oesophageal funnel. The dorsal ray of the bursa before its final division has an irregular outline. In some specimens this has the shape of one or two processes, but this feature is not constant. Lane did not see ova in any of his female specimens. I am able to record their measurements as  $62 \mu$  long by  $32 \mu$  broad.

*Habitat.* Stomach of the African elephant (South Africa and Uganda).

#### PTERIDOPHARYNX ANISA Khalil, 1922. (Text-figs. 47-51.)

*Source of material.*—The material consists of more than thirty specimens. These I sorted out from the large stock of parasites collected by Prof. Leiper in Uganda.

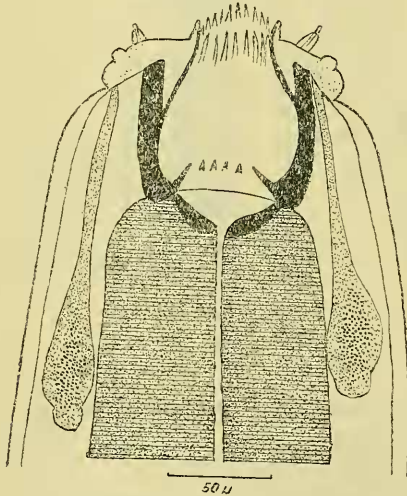


*Shape of body.*—In the preserved condition the body of both males and females is practically straight. The male is 14–15 mm. long. The female is slightly longer, being on an average 16·5–17 mm. The greatest diameter of the body is about the middle, being ·46 mm. in the male and ·65 mm. in the female. The body tapers slightly towards the head end and the caudal end. In the female the tail becomes suddenly constricted from the body, appearing to the naked eye as a spinous process projecting from the posterior end of the body.

*Skin.*—The skin is finely striated throughout the whole length of the body, including the tail of the female. The striations are regularly placed at distances of  $10\ \mu$  between. There is no cuticular expansion.

*Mouth collar.*—The mouth collar has a rounded outline. It is separated from the rest of the body by a distinct groove. The diameter of this collar is shorter than that of the body in its immediate neighbourhood. It is ·125 mm., while its length is ·02 mm.

Text-figure 47.

*Pteridopharynx anisa* Khalil. Head.

*External leaf-crown.*—This consists of twenty leaflets, broad at their base and sharp at their termination. The outline of the tips of these leaflets, seen from the ventral aspect, forms a crescent, being longer in the centre than at either side.

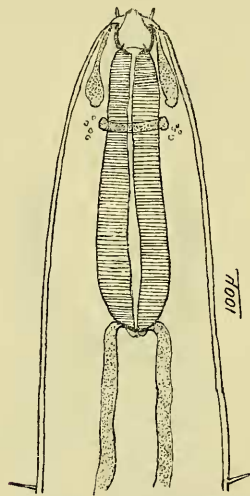
*Head papillæ.*—The four submedian head papillæ are long, and each surmounted with a small knob. The latter is apparently continuous with a core inside the papilla, and presumably represents the duct of a head gland. The two lateral papillæ do not project above the surface; their terminations are marked by a depression in the cuticle.

*Cervical papillae*.—These are long and thin. They are placed .92 mm. from the cephalic end of the body.

*Mouth capsule*.—The mouth capsule is pear-shaped. It is longer than it is broad. It is .093 mm. long and .065 mm. in maximum diameter. The chitinous plate forms the wall of the posterior half of the mouth capsule, and a funnel-like extension of it forms the wall of the anterior portion. The chitinous plate is .06 mm. long; its upper end is sharply cut in an oblique direction. From the posterior end of this chitinous ring project a series of sharp teeth-like processes overhanging the opening of the œsophagus.

*Esophagus*.—There is a broad, shallow œsophageal funnel bordered by a thick cuticular edge. The length of the œsophagus is .45 mm. in the male and .57 mm. in the female. Its maximum

Text-figure 48.



*Pteridopharynx anisa* Khalil. Ventral view of cephalic end of body.

diameter is .14 mm. in either sex. There is hardly any constriction at the site of the nerve collar.

*Chyle intestine*.—The beginning of the chyle intestine overlaps the œsophagus. It pursues a straight course to the rectum. The cellular lining of its walls is pigmented in its middle. The lumen narrows before joining the rectum.

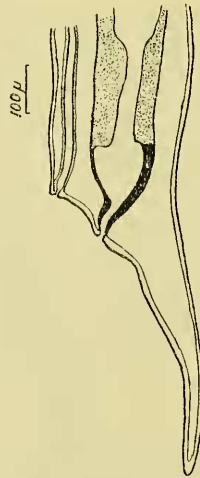
*Rectum*.—This has a wide funnel-shaped cavity in the female. It has a thin cuticular lining in contradistinction to the thick cellular wall of the intestine. The caudal end of the rectum narrows to a short narrow anal canal, the opening of which is surrounded by a slightly raised lip.

*Excretory pore*.—The excretory vesicle is a small fusiform sac, with a short duct opening .87 mm. from the cephalic end on the ventral surface.

*Head glands.*—There are four elongated, deeply pigmented bodies surrounding the beginning of the œsophagus. They contain orange-coloured granules, suggesting their being glandular. Their anterior end is elongated in the form of a duct lying to the outer side of the chitinous ring of the mouth capsule. Their exact termination could not be made out, but probably they traverse the submedian head papillæ and open at their tip. The presence of ducts opening on the tip of the head papillæ was first recorded by Cooper Curtice and confirmed by Giles in *Æsophagostomum columbianum*.

Both these observers, however, interpreted them to be the ducts of the lateral canals. Looss' comment was: "I do not entertain the slightest doubt that they have seen the outlet of the head-glands."

Text-figure 50.



*Pteridopharynx anisa* Khalil.  
Female tail.

Text-figure 49.



*Pteridopharynx anisa* Khalil.  
Ovum.

*Nerve collar.*—The thick nerve collar is .25 mm. from the head end.

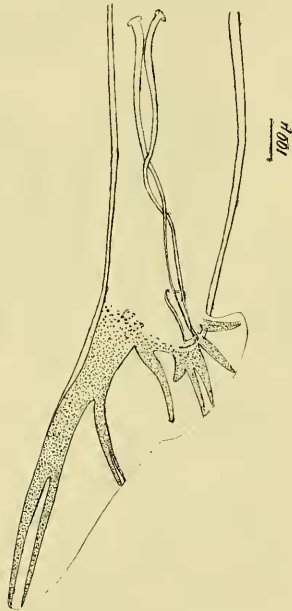
*Genital organs.*—The male testes are irregularly convoluted, reaching to within 3 mm. of the head. The cement gland is long, terminating at the base of the genital cone, where the ejaculatory duct opens into the cloaca.

The female vagina is a long, straight canal lying in the axis of the body. At its cephalic end the two strongly muscular ovejectors open into it, connecting it with the corresponding uterus. The convolutions of the ovaries reach to within 4.5 mm. of the cephalic end of the body.

*Bursa*.—The bursa is long, and is indistinctly separated into three lobes, especially when seen in a side view. The elongation is due mainly to the dorsal lobe. The bifid ventral ray is short and placed close to the cephalic end of the bursa, where it may be overlooked on casual examination.

The lateral group of rays arises by a common trunk, and, in addition to the ordinary three branches, gives a fourth stumpy-looking ray. This is directed caudally. The externo-dorsal ray is stout and arises close to the lateral rays. It does not reach the edge of the bursa. The dorsal ray is .7 mm. long. It gives a

Text-figure 51.



*Pteridopharynx anisa* Khalil. Lateral view of male bursa and spicules.

branch on either side after .18 mm. course. The ending of each of these branches is bifid. This bifurcation can be traced for a longer distance than in *P. africana*. The main stem of the dorsal ray after another course of .2 mm. divides into two branches which end at the posterior limit of the bursa. The bursa is .82 mm. long and .47 mm. broad.

*Genital cone*.—This has a truncated apex. The cloacal opening is surrounded by a protruding lip, and is directed ventrally and caudally.

*Spicules*.—The two similar spicules are .82 mm. in length.

Their cephalic ends are thick and surrounded by an everted lip. In their course they apparently entwine each other. Their tips are sharp and curved backwards. The accessory piece is .13 mm. long and curved dorso-ventrally.

*Termination of the female.*—At the level of the vulva the ventral surface curves towards the dorsum, forming a conical-shaped tail. The opening of the vulva is directed caudally. The anus opens .12 mm. posterior to the vulva, and is also directed caudally. The tail is .52 mm. in length; its end is rounded. There are two caudal papillæ marked on the surface by a depression .33 mm. from the extremity of the tail.

*Ova.*—The ova in the terminal portion of the uterus measure  $48\ \mu$  by  $30\ \mu$ . They are then in the morula stage.

*Habitat.* Intestine of African elephant (Uganda).

#### Discussion.

This species differs from *P. africana* in the shape of the mouth capsule, which is more elongated; the absence of the plumose appearance of the œsophagus; the greater distance between the vulva and anus; and the general appearance of the tail in the female. In the male the spicules are shorter, and the bifid end of the branch of the dorsal ray is also much longer. The total length of the body and of the various structures are also different.

As the plumose corrugation of the œsophagus for which Lane suggested the generic name *Pteridopharynx* is absent, this can only be considered a specific character. The same plumose appearance is present in *Memphisia aziza*, which undoubtedly belongs to a different genus on account of the configuration of the head and the presence of an additional ray in the bursa, both of which are important morphological characteristics.

#### Genus MEMPHISIA Khalil, 1922.

Body is slender. The rays of the external leaf-crown do not project freely above the head. The oral cavity is deep, and is wider from side to side than from before backwards. There are chitinous teeth in the floor of the mouth capsule. A shallow œsophageal funnel is present. The œsophagus is short and thick. Plumose appearance of the cephalic end of the lumen of the œsophagus may or may not be present.

Just caudad to the mouth collar the cuticle is raised to form a collar surrounding the circumference of the body. The degree of projection of this cuticular collar varies in the two species.

Male. The lateral ray has an accessory ray on its posterior border. The externo-dorsal ray has a branch directed caudally. Of the three branches of the dorsal ray the outer two are fused to nearly their tips. Their dual nature is indicated by ending in two papillæ. The two spicules are equal and similar. An accessory piece is present.

Female: The vulva lies closely anterior to the anus. The distance between the two openings varies in the different species. The vagina runs anteriorly in the axis of the body. The two parallel uteri are provided with strong ojectors.

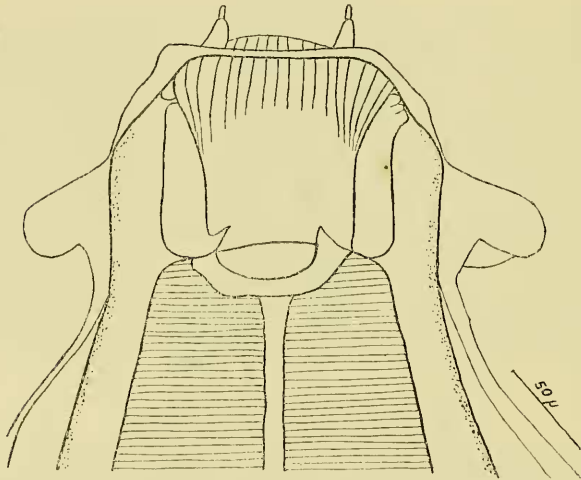
Type-species, *Memphisia memphisia* Khalil, 1922.

*MEMPHISIA MEMPHISIA* Khalil, 1922. (Text-figs. 52-58.)

*Material.*—The material consists of more than sixty specimens sorted out of Prof. Leiper's Uganda collection.

*Shape of body.*—The body is slender, and in the preserved state straight. The males vary between 13.5 and 14 mm. in length. The females are slightly longer, 14.5-16 mm. in length. The maximum diameter is about the middle of the parasite, being

Text-figure 52.



*Memphisia memphisia* Khalil. Ventral view of head.

·55 mm in either sex. The body is slightly attenuated at the cephalic end. Just posterior to the mouth the body is encircled with a thick cuticular collar. The tail of the female is suddenly constricted from the body, appearing to the naked eye as a large posteriorly placed spine.

*Skin.*—The cuticle is closely striated at intervals of about 10  $\mu$ . Towards the anterior end of the body the cuticle becomes inflated, forming in optical section two alae which surround the whole circumference of the body. It is .2 mm. long, and extends .03 mm. beyond the circumference of the body. It is placed at the level of the anterior part of the œsophagus.

Anterior to this is a definite collar-like expansion of the



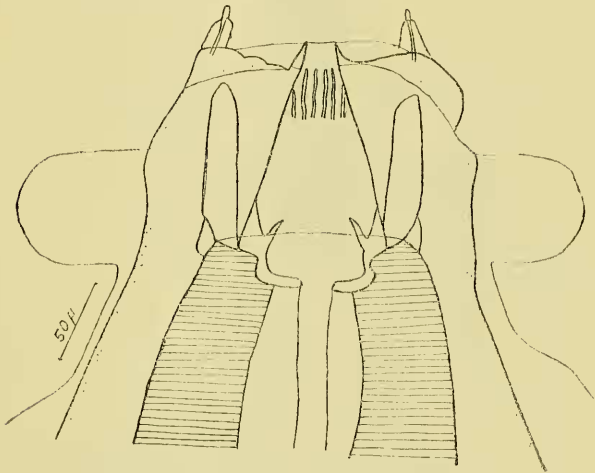
cuticle, sharply demarcated from the rest of the body. It is  $\cdot 05$  mm. long, and projects by the same amount from the body. The anterior cuticular expansion is not striated, but the posterior is.

*Mouth collar.*—This is very short and indistinctly separated from the rest of the body. It is  $\cdot 02$  mm. in length and  $\cdot 12$  mm. in diameter.

*Anterior leaf-crown.*—This consists of 36 incompletely separated leaflets. They do not project freely above the mouth collar.

*Head papillæ.*—There are four submedian head papillæ. They are stumpy and surmounted with knobs continuous with, apparently, a duct traversing the papilla. The two lateral head papillæ do not project on the surface.

Text-figure 53.



*Memphisia memphisia* Khalil. Lateral view of head.

*Cervical papillæ.*—These are very long and delicate. They are placed  $\cdot 92$  mm. from the cephalic extremity.

*Mouth capsule.*—Seen from the ventral surface the mouth capsule is practically quadrangular, being slightly broader at the outlet. A side view shows the same structure as funnel-shaped, narrowing at the outlet. The length of the oral cavity is  $\cdot 08$  mm.; its maximum breadth is  $\cdot 09$  mm., and from before backwards it measures  $\cdot 05$  mm. The chitinous ring surrounding the oral cavity is thick and nearly vertical. Its upper extremity is slightly bent peripherally, as seen in ventral view. There are two teeth projecting into the mouth cavity.

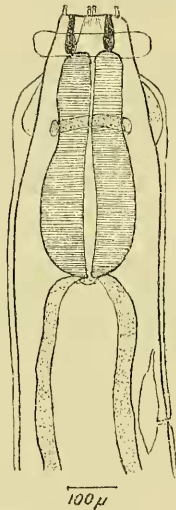
*Œsophagus.*—There is a shallow œsophageal funnel lined with cuticle. The œsophagus is short and broad. It is  $\cdot 48$  mm. in

length and .18 mm. maximum diameter, and is very slightly constricted at the site of the nerve collar. The caudal end of the œsophagus projects into the beginning of the chyle intestine in the form of three lobes.

*Chyle intestine.*—This pursues an almost straight course. Its cellular wall is pigmented in its middle portion.

*Rectum.*—The intestine is sharply demarcated from the rectum. The thick cellular wall of the intestine stops abruptly. The wall of the rectum is very thin and chitinous. Its cavity is pear-shaped, .18 mm. long and .1 mm. maximum diameter. There is hardly any anal canal. The opening of the anus is marked by a depression. There is a lip-like projection between the anus and the vulva.

Text-figure 54.



*Memphisia memphisia* Khalil. Lateral view of cephalic portion of body.

*Nerve collar.*—The thick nerve collar is placed round the œsophagus .25 mm. from the cephalic end.

*Genital organs.*—Male: The testes are convoluted irregularly, reaching to within 3 mm. of the head. There is a dilated, elongated vesicula seminalis. The ejaculatory ducts penetrate the cement gland. This is of enormous length, and is apparently divided into three parts by deep grooves. The ejaculatory ducts open into the cloaca.

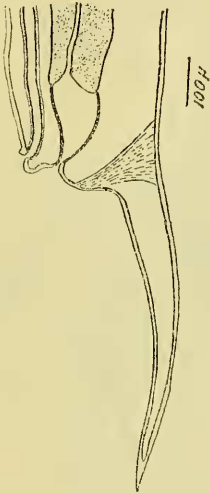
Female: The thin-walled vagina proceeds cephalad in the long axis of the body. The two strongly muscular ovejectors open into its apex side by side, connecting it with the two dilated

uteri, which are packed with eggs. The ovaries are irregularly convoluted, reaching within 4.3 mm. of the head. The vagina is 1.7 mm. long.

*Bursa*.—The bursa is elongated, and distinctly divided into three lobes. The dorsal lobe is nearly double as long as the lateral lobes. The whole bursa is .75 mm. long and .55 mm. broad. The ventral, lateral and externo-dorsal rays are crowded together, while the branches of the dorsal ray are wide apart.

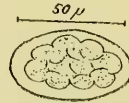
The bifid ventral ray is placed near the anterior edge of the bursa. The lateral, in addition to the usual three branches, gives a fourth stumpy ray, directed caudally. The externo-dorsal ray

Text-figure 55.



*Memphisia memphisia* Khalil.  
Female tail.

Text-figure 56.



*Memphisia memphisia* Khalil.  
Ovum.

does not reach the edge of the bursa. Near its origin it gives a long branch, directed caudally and having a rounded extremity. It is .1 mm. in length, and is constantly present in all the males examined.

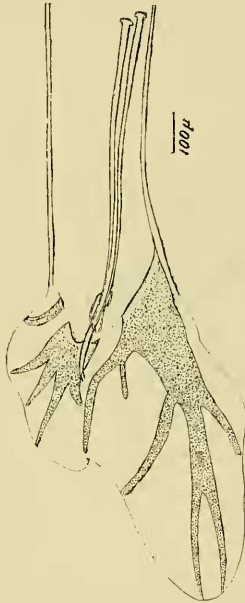
The dorsal ray is .7 mm. long. It gives a branch on either side before ultimately dividing into two rays. The first two branches have a double papilla at their end. The terminal branches end a long distance apart at the caudal extremity of the bursa.

*Genital cone*.—The genital cone is placed nearer the ventral than the dorsal surface of the body. The cloacal opening is placed a little posterior to its apex, and is surrounded with four ill-defined cuticular knobs.

*Spicules.*—The two similar spicules are .9 mm. long. They are thin, with a fine termination bent dorsally. There is a short accessory piece .1 mm. long, curved on itself, forming a canal for the spicules, and also arched in the longitudinal axis; the concavity produced is directed dorsally. The cephalic third of the spicular sheath is finely striated transversely.

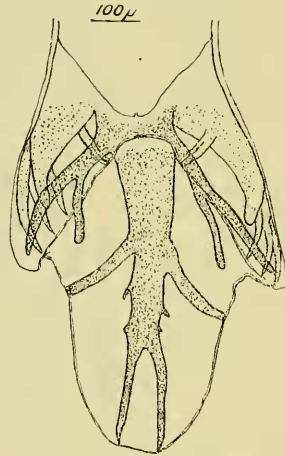
*Termination of female.*—The vulval opening is surrounded by a prominent lip, especially on the caudal side. This latter

Text-figure 57.



*Memphisia memphisia* Khalil.  
Male bursa, lateral view.

Text-figure 58



*Memphisia memphisia* Khalil.  
Male bursa, ventral view.

separates the vulva from the anus. Both openings are directed practically caudally. The distance between the two openings is .08 mm. At this level the diameter of the body is suddenly constricted, changing from .26 at the level of the vagina to .1 mm. a little below the anus. The tail is .58 mm. long, and its end is pointed.

*Ova.*—Ova found in the vagina are in the morula stage, and measure  $55\ \mu$  by  $35\ \mu$ .

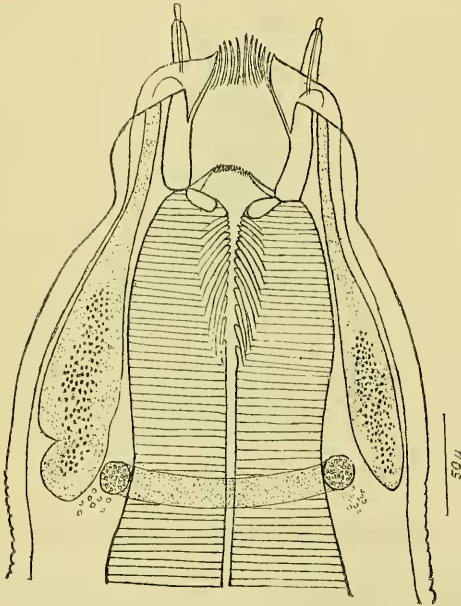
*Habitat.* Intestine of African elephant (Uganda).

*MEMPHISIA AZIZA* Khalil, 1922. (Text-figs. 59-64).

*Material*.—The material consists of more than sixty specimens sorted from Prof. Leiper's collection.

*Shape of body*.—The body is slender. It is slightly shorter than *M. memphisia*. The males are 12 mm. long and the females are 15 mm. The maximum diameter is about the middle of the body, being .5 mm. in both sexes. The head end is very narrow, being .1 mm in diameter. There is a cuticular collar, less projecting than in *M. memphisia*. There is no cuticular expansion. The female tail is less abruptly constricted than is the type-species.

Text-figure 59.



*Memphisia aziza* Khalil. Ventral view of head.

*Skin*.—The cuticle is very finely striated. The striations are at intervals of .01 mm. The cuticular collar is demarcated from the body by a shallow groove.

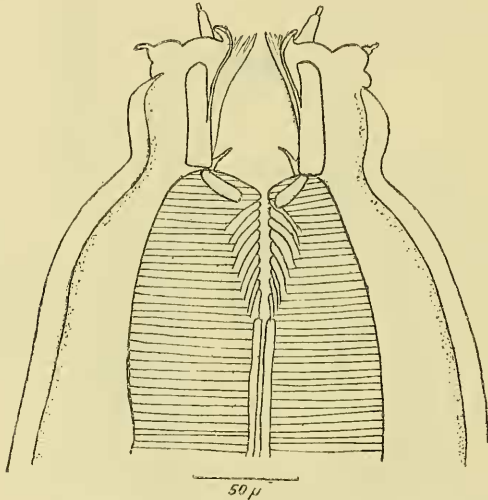
*Mouth collar*.—The mouth collar is distinctly separated from the rest of the body by a groove. It is irregularly rounded when seen laterally, and almost quadrangular when seen from the ventral or dorsal surface. The latter appearance is due to the presence of the lateral head papillæ being on the extreme

edge of the mouth collar. The mouth collar is .02 mm. long and .1 mm. in diameter.

*Head papillae.*—The four submedian head papillae are fairly long, with a knob-like mass on their top. This is continuous with a duct-like canal passing in the substance of the papillae and previously alluded to as possibly the duct of a corresponding head gland. The two lateral papillae are small and delicate, and directed mainly laterally, giving the square-like appearance to the head.

*External leaf-crown.*—This is composed of 24 thin leaflets surrounding the oval-shaped mouth-opening. Seen from the

Text-figure 60.



*Memphisia aziza* Khalil. Ventral view of head.

ventral aspect the rays in the centre project more than those on either side.

*Cervical papillae.*—The long and thin cervical papillae are placed .82 mm from the cephalic extremity.

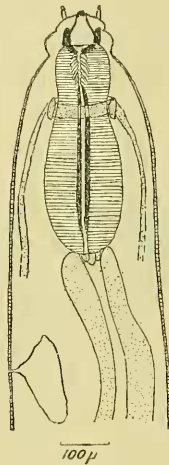
*Mouth capsule.*—The oral cavity is longer than it is broad. It is pear-shaped, being narrow at its outlet. The chitinous ring surrounding the oral cavity is very thick, and almost rectangular in optical section. It is .045 mm. in length and .072 mm. in diameter. A thin chitinous offshoot surrounds the oral cavity in its terminal half. At the floor of the mouth capsule there is a ring of 24 sharp teeth, probably representing an internal leaf-crown.

*Cephalic glands.*—There are four cephalic glands surrounding

the anterior part of the œsophagus from the level of the nerve collar to the mouth collar. They are placed in the submedian planes. Each has a long, thick duct, which can be traced easily to the level of the groove separating the mouth collar from the body. As has been mentioned already, probably these ducts open on the top of the submedian head papillæ. Their contents are big granules in the centre, surrounded by fine granules which also fill the ducts.

*Esophagus*.—There is a shallow œsophageal funnel surrounded by a thick chitinous wall. The lumen of the anterior .07 mm. of the œsophagus is ridged, having a plumose appearance similar to that seen in *P. africana*. The rest of the lumen of the œsophagus is .4 mm. in length and

Text-figure 61.



*Memphisia aziza* Khalil. Lateral view of cephalic portion of body.

.14 mm. maximum diameter. It is slightly constricted at the site of the nerve collar. The caudal termination of the œsophagus projects into the lumen of the chyle intestine, forming three small lobes.

*Chyle intestine*.—The cellular wall of the chyle intestine is pigmented throughout its entire course. It pursues a nearly straight course.

*Rectum*.—This is a short tubular structure, with chitinous wall sharply demarcated from the rest of the intestine.

*Excretory system*.—The excretory vesicle is large and oblong. The short excretory ducts open in the median ventral line .72 mm. from the cephalic extremity.

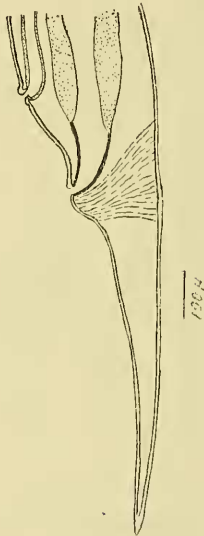


*Nerve collar*.—This is placed .2 mm. from the head surrounding the oesophagus.

*Genital organs*.—Male: The irregularly convoluted testes reach within 2.5 mm. of the head extremity. There is a dilated seminal vesicle. The ejaculatory duct traverses the long cement gland to terminate in the cloaca.

Female: The vagina pursues a vertical course in the long axis of the body. It is .52 mm. long. Into its cephalic end the two strongly muscular ovejectors open, each connected with the corresponding uterus. The two uteri lie side by side, lying mainly in the axis of the body. The irregularly convoluted ovary reaches within 2.75 mm. of the head end.

Text-figure 62.



*Memphisia aziza* Khalil.  
Female tail.

Text-figure 63.



*Memphisia aziza* Khalil.  
Ovum.

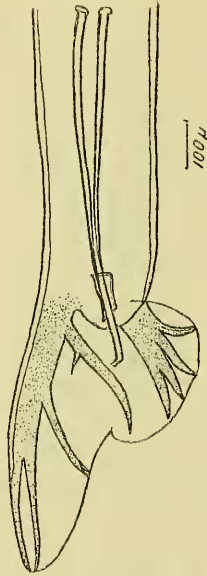
*Bursa*.—The bursa is distinctly divided into three lobes. The dorsal lobe is much longer than the lateral. The bursa is smaller than that of *M. memphisia*, but corresponds to it in shape and in the arrangement of the rays. It is .5 mm. in length and .45 mm. in breadth. The ventral and lateral rays are similar to the corresponding rays in the type-species. The fourth division of the lateral ray is shorter and knob-like. The externo-dorsal ray does not reach the edge of the bursa. It gives off near its origin a small ray, which is characteristic of the genus. It is shorter than that in *M. memphisia*, being .05 mm. in length, and its end is pointed.

The dorsal ray is .47 mm. long. Each of its first two branches terminate in two papillæ. The terminal two branches terminate close to each other at the caudal end of the bursa.

*Genital cone.*—This blunt cone projects from the roof of the bursa nearer the ventral than the dorsal surface. The cloacal opening is a little dorsal to its apex. It is surrounded by cuticular bosses.

*Pre-bursal papillæ.*—The pre-bursal papillæ are fairly long, and are placed .7 mm. from the caudal end of the bursa.

Text-figure 64.



*Memphisia aziza* Khalil. Male bursa.

*Spicules.*—The two similar spicules are .75 mm. long. Their tips are curved, pointing dorsally. The spicular sheath is transversely striated in its upper third. The accessory piece is .1 mm. long, and is curved from side to side, enclosing the spicules. It is also arched in the longitudinal axis; the concavity is directed dorsally and caudally.

*Termination of the female.*—The tail of the female tapers gradually to a point, unlike the suddenly constricted tail of *M. memphisia*. The vulva is placed .25 mm. cephalad of the anus. The tail is .66 mm. long. There are two caudal papillæ, marked by a slight depression in the lateral line. These are placed .14 mm. from the tip of the tail.

*Ova*.—The ova, as seen in the vagina, are thin-shelled. They are 60  $\mu$  in length and 35  $\mu$  in breadth. The contents are in the morula stage of development.

*Habitat*. Intestine of African elephant (Uganda).

#### Discussion.

This genus is in some respects allied to *Pteridopharynx*. The presence, however, of the cuticular collar round the anterior end of the body, and the peculiarity of having a branched externo-dorsal ray in the bursa, clearly differentiate the members of the genus *Memphisia*.

The two species here described are easily sorted out, even with a hand lens. The very marked and projecting cuticular collar of *M. memphisia*, together with the spike-like female tail, suffice to differentiate them. The spicules in *M. aziza* are shorter; the distance between the anus and vulva is longer than in *M. memphisia*. In addition, the total length and the diameter of the various structures of the body and the position of the cervical papillæ and excretory pore are different in both species.

No member of this genus has been recorded from the Indian elephant.

#### Genus AMIRA Lane, 1914 (amended).

Fairly small worms with thick cuticle. Cuticular bosses may be found anterior to the male bursa. The mouth is terminal, and is surrounded by an external and an internal leaf-crown. There are six head papillæ, none of which are prominent. The mouth capsule is very short; the œsophagus is hour-glass in shape, the nerve collar surrounding the constriction. There is a large œsophageal funnel. The œsophagus has a cuticular lining.

The male: The dorsal lobe of the bursa may or may not be enormously elongated. The pre-bursal papillæ are very much elongated. The two equal spicules are of enormous length and very fine. There is an accessory piece.

The female: The vulva lies close cephalad of the anus. The long vagina runs cephalad, and divides into two parallel cephalad-running uteri provided with ovejectors. The colourless thin-shelled ova are segmented.

Type, *Amira pileata* Railliet, Henry & Bauche, 1914.

AMIRA PILEATA Raill., Henry & Bauche, 1914. (Text-figs. 65–68.)

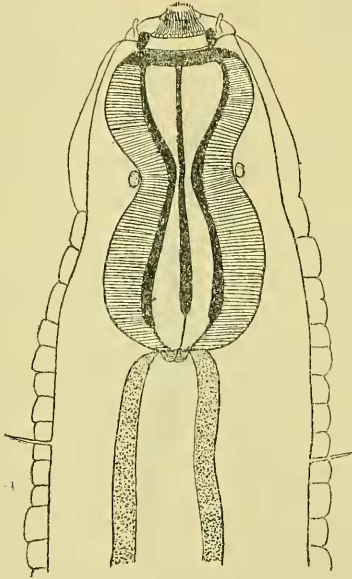
*Cylicostomum pileatum* Raill., Henry & Bauche, March 1914.

*Amira omra* Lane, July 1914.

*Source of Material*.—The material consists of one male and five females, which were sent to Prof. Leiper by Lieut.-Col. Clayton Lane. They are the co-types of *Amira omra*.

*Historical Review.*—This species was independently described by Railliet and his co-workers on the one hand, and by Lane on the other. The descriptions in some respects are complementary. Lane definitely mentions that an accessory piece is absent. Railliet and his colleagues do not mention it at all. There is important discrepancy in the bursal rays as described and drawn. Lane records the presence of a long pre-bursal papilla assuming the appearance of a ray and lying close in front of the double ventral ray. This is completely missed by the other observers. On the other hand, Railliet figures two small branches to the dorsal ray, while Lane records one only. The head end is well

Text-figure 65.



*Amira pileata* Raill., Henry & Bauche. Cephalic portion of body.

represented in the diagram of Railliet. It is thought advisable to re-describe the bursa.

The *Bursa* is greatly elongated. This is due mainly to the length of the dorsal lobe. The bursa is 1.9 mm. in length and 0.55 mm. in breadth. The cuticle in front of the bursa on the ventral surface is very much thickened. The free edges of the lateral lobes of the bursa are folded inwards, obscuring the exact mode of ending of the lateral rays.

The pre-bursal papilla is very long and thin. It pursues a wavy course, and ends close to the termination of the ventral ray. It is 0.25 mm. in length.

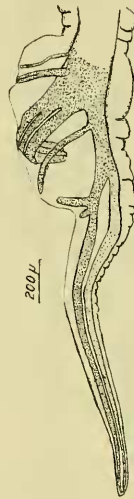
The ventral ray is bifurcated in its terminal half. The two branches lie close together. The anterior branch is thinner than the posterior.

The three lateral rays have a common origin. The postero-lateral ray branches before the other two rays. All three rays lie close to each other throughout their entire course. Their terminal third is folded inside the bursa.

The externo-dorsal ray is slender, and pursues a curved course. It does not reach the edge of the bursa, but ends by a papilla on the external surface.

The dorsal ray is unique in virtue of its enormous length. It measures 1.67 mm., and divides high up within .15 mm. of its origin. After a short course each primary division gives off

Text-figure 66.



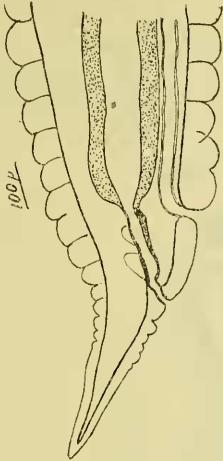
*Amira pileata* Raill., Henry & Bauche. Male bursa.

a long and a short branch lying close to each other. The longer branch is .12 mm. and the shorter .05 mm. in length. These branches appear as offshoots from the main stem, which continues a straight course, parallel and close to the corresponding ray of the other branch. Both end in a sharp point.

*Genital cone.*—The cloacal opening is placed near the apex of an elongated genital cone. The cone projects from the roof of the bursa between the pre-bursal papillæ. It is placed ventrally and caudally, and is .18 mm. in length and .04 mm. in breadth. The cloacal canal traverses its centre. Its opening is overlapped by its projecting anterior lip, which forms the apex of the cone.

Along the dorsal wall of the cloacal canal is placed the accessory piece. It is grooved on its ventral surface with curved edges. The cephalic extremity is slightly broad. The caudal lies a

Text-figure 67.



*Amira pileata* Raill., Henry & Bauche.  
Female tail.

Text-figure 68.



*Amira pileata* Raill., Henry & Bauche.  
Ovum.

short distance cephalad of the apex of the genital cone. Its total length is .165 mm.

*Habitat.* Cæcum of the Indian elephant (India).

AMIRA SAMEERA, sp. n. (Text-figs. 69-71.)

*Source of Material.*—The material consists of a single male discovered accidentally amongst the type material of *Pteridopharynx africana* Lane, deposited in the Natural History Museum. I was enabled to examine this material through the kindness of Dr. Baylis. It was collected at Lawrence Hill, Addo Bush, Cape Province, Africa, and was presented to the Natural History Museum by the Imperial Bureau of Entomology in August 1919. This collection had been examined by Lieut.-Col. Clayton Lane, and had been separated by him into two hitherto undescribed species. Careful search through the whole material failed to discover further specimens of *A. sameera*.

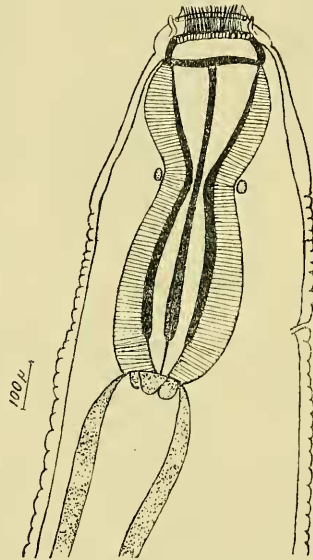
*Shape of body.*—Body is stout in comparison with its length. It is 10.5 mm. long. The greatest diameter of the body is about its middle, where it is .45 mm. It tapers slightly towards the head, and also towards the caudal end, just anterior to the bursa, which, however, gives a truncated appearance to the posterior extremity of the male.

*Skin*.—The skin is striated to within a short distance of the head. The striations are crowded near the cephalic extremity, where they are  $\cdot 02$  mm. apart; at the middle of the body they are  $\cdot 025$  mm. apart, while near the bursa they are far between, being on an average  $\cdot 06$  mm. apart.

The thickness of the cuticle is  $\cdot 02$  mm. in the cephalic two-thirds of the body; caudally it becomes thicker. Near the bursa the cuticle reaches its maximum thickness,  $\cdot 08$  mm.

*Mouth collar*.—This is distinctly separated from the rest of the body by a shallow groove. It is regularly rounded in outline. Its length is  $\cdot 048$  mm. and its diameter  $\cdot 25$  mm.

Text-figure 69.

*Amira sameera*, sp. n. Cephalic portion of body.

*External leaf-crown*.—The inner surface of the mouth collar is occupied by a circular crown consisting of 36 leaflets. These leaflets are slender,  $\cdot 065$  mm. in length, and tapering at their free end.

*Head papillæ*.—The four submedian head papillæ are short and conical. The two lateral papillæ have a rounded top.

*Cervical papillæ* could not be made out in this specimen.

*Mouth capsule*.—The shallow mouth capsule is  $\cdot 05$  mm. deep and  $\cdot 165$  mm. in diameter. The chitinous plate surrounding the mouth is thick and curved. Its concavity faces the lumen of the mouth.

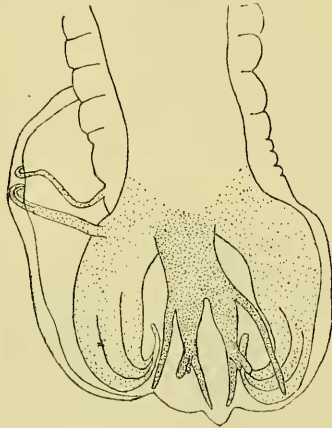


*Internal leaf-crown.*—This is placed over the top of the chitinous ring of the mouth capsule. It consists of 36 very short leaflets corresponding to those of the external crown.

*Esophageal funnel.*—This is large and characteristic of the genus. It ends at the level of the nerve-ring where the œsophagus is constricted. There are three chitinous plates lining this funnel as well as the rest of the œsophagus. The cavity of the funnel is .21 mm. in length and .175 mm. maximum diameter.

*Esophagus* is short and thick. It is bulbous at either end and constricted where the nerve collar is placed. The total length of the œsophagus is .6 mm.; the anterior portion is .21 mm. and the posterior .39 mm. The diameter of the anterior portion is .25 mm., while the posterior is .22 mm. The posterior end of the

Text-figure 70.

100  $\mu$ *Amira sameera*, sp. n. Dorsal view of bursa.

œsophagus projects into the beginning of the chyle intestine, forming three small lobes.

*Chyle intestine.*—The course taken by the chyle intestine is practically straight. Its wall is thick and the cells are not pigmented.

*Excretory system.*—The excretory pore is placed .7 mm. from the head end. The thin-walled excretory vesicle lies close by and has a thin wall.

*Nervous system.*—The nerve collar is .33 mm. from the head end. It lies in the deep constriction of the œsophagus.

*Genital organs.*—The convolutions of the testes reach to within 1.3 mm. of the head. They run for the most part in the axis of the body. The cement gland is nearly half the length of the body.

*Bursa*.—The bursa has a wrinkled appearance. Its edges are curled inside. The dorsal is indistinctly separated from the lateral lobes. It is not elongated as in *A. pileata*. The general arrangement of the rays, however, is common to both species. The bursa is .67 mm. long and .54 mm. broad.

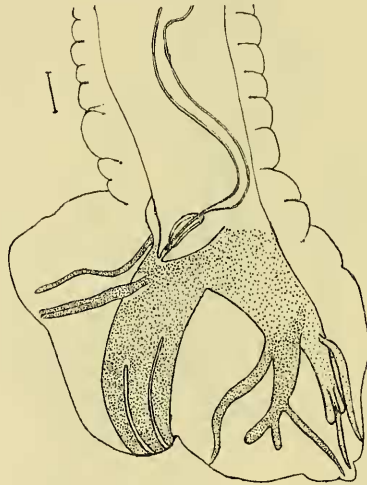
The pre-bursal papilla is thin and wavy, and is .3 mm. in length. It is easily mistaken for a ray.

The ventral ray is bifid in its terminal half. The two branches lie close together.

The lateral rays lie close together, and their terminations are bent inwards exactly in the same manner as in *A. pileata*.

The externo-dorsal ray is long and ends very near the edge of the bursa.

Text-figure 71.



*Amira sameera*, sp. n. Lateral view of bursa.

The dorsal ray is massive. It divides at the level of the origin of the externo-dorsal ray. Each of these primary divisions gives a thick, short lateral branch, which almost immediately divides into two. These are very short and do not reach the edge of the bursa. The main stem is longer and ends near the corresponding ray of the other side.

The length of the dorsal ray is .25 mm.

*Genital cone*.—The genital cone is sharply pointed. It is, however, a more massive structure than that of *A. pileata*. The apex of the cone lies nearly in a line with the ventral surface of the body. It is not marked with any cuticular thickenings.

*Genital opening*.—The cloacal opening is placed practically at the apex of the genital cone.

*The spicules.*—The elongated spicules pursue a wavy course. They are about 2·9 mm. in length. Their tips are thickened. The accessory piece is short, ·12 mm. in length. It is strongly curved from side to side, and less so in the longitudinal direction. The concavity of the latter curvature is directed caudally and dorsally.

*Habitat.* The stomach of the African elephant (South Africa, Addo Bush).

#### *Discussion.*

The striking difference between the two species of the genus *Anura* is the shape of the bursa. On careful study, however, this difference is minimized by the great similarity between the arrangement of all the rays and the pre-bursal papillæ. The dorsal rays in both species have six branches each. Four of these branches are little more than bud-like processes. The remaining two branches are enormously elongated in *A. pileata* and short in *A. sameera*. This I considered as a specific difference. It is not justifiable to regard it as generic. For this reason I have had to amend Lane's generic diagnosis. The configuration of the mouth, the œsophagus, and spicules are strikingly similar, with differences as regards size only.

#### Genus EQUINURBIA Lane, 1914.

Fairly large and stout bursate nematodes. There are an external and an internal leaf-crown. The mouth capsule and the oral cavity are more or less globular. The dorsal œsophageal gland discharges through a dorsal gutter.

Male: There are 11 pairs of rays supporting the male bursa, of which two are ventral, three are lateral, three are externo-dorsal, and three are dorsal. The spicules are equal and similar. There is no accessory piece.

Female: The vulva opens on the summit of a prominence adjoining the anus. The uteri are convergent and lie parallel to each other, and are furnished with weak ovejectors.

Type-species, *Equinurbia sipunculiformis*.

EQUINURBIA SIPUNCULIFORMIS Baird, 1859.

*Sclerostoma sipunculiforme* Baird, 1859.

Nematode No. 4. Evans & Rennie, 1910.

*Cylicostomum sipunculiforme* Raill., Henry & Bauche, 1914.

*Equinurbia sipunculiforme* Lane, 1914.

This species has the characteristics of the genus. Males are 15 mm. long and 1·3 maximum diameter. The female is 27·5 mm. long and 1·5 mm. maximum diameter. The spicules are 1·5 mm. long. The tail of the female is 0·8 mm. long. The ova are 60  $\mu$  in length and 30–35  $\mu$  in breadth.

*Habitat.* Cæcum of the Indian elephant (India).

## Family ANCYLOSTOMIDÆ Looss, 1911.

## Sub-family ANCYLOSTOMINÆ Raill. &amp; Henry, 1909.

## Genus GRAMMOCEPHALUS Raill. &amp; Henry, 1910.

The head is curved towards the dorsum. Mouth capsule is wide anteriorly and narrowed posteriorly. There are three teeth projecting from the dorsal and lateral walls of the mouth capsule. Œsophagus is long and simple. From the dorsal wall of the intestine, close to its union with the œsophagus, springs a long diverticulum, running cephalad. The dorsal rays are bifid near their tips. There are two similar spicules and no accessory piece. Vulva lies close to the middle of the body. The short vagina is joined by two divergent uteri.

Type-species, *Grammocephalus clathratus*.

GRAMMOCEPHALUS CLATHRATUS Baird, 1868.

*Sclerostoma clathratum* Baird, 1868.

*Strongylus clathratum* Cobbold, 1882.

*Grammocephalus clathratum* Raill. & Henry, 1910.

Male is 45.52 mm. in length and 1.15 mm. in maximum diameter.

Female is 36 mm. long and 1.03 mm. in maximum diameter.

The median dorsal tooth is not particularly prominent. The intestinal diverticulum is 2.3 mm. long. The spicules of the male are 1.2 mm. in length. The female tail is 0.67 mm. long. The vulva is 17 mm. cephalad of the anus. The main stem of the dorsal ray is longer than that of the next species.

*Habitat.* Bile-ducts of the African elephant (South Africa).

GRAMMOCEPHALUS VAREDATUS Lane, 1921.

Probably the supposed *G. clathratus* reported from the Indian elephant were really this species. These were:—

*Strongylus clathratum* Cobbold, 1882.

*Sclerostomum clathratum* Piana & Stazzi, 1900.

Nematode No. 1. Evans & Rennie, 1910.

*Grammocephalus varedatus* Lane, 1921.

This is a somewhat longer species. The males are 55 mm. long and the females are 47 mm. The dorsal ray divides close to its origin. The spicules are 1.35 mm. in length. The female tail is 0.8 mm. in length, and the vulva lies 22 mm. cephalad of the anus.

*Habitat.* The bile-ducts of the Indian elephant (India and Burma).

## Genus BATHMOSTOMUM Raill. &amp; Henry, 1909.

Small nematodes having the head curved towards the dorsum, the oral aperture facing anteriorly and dorsally. The oral capsule is fissured on its dorsal and lateral aspects. Its internal surface is raised mainly ventrally and laterally into shelf-like projections encroaching on the oral cavity. A small dorsal tooth surmounts the dorsal column of the œsophagus, which is simple and cup-shaped.

Male: The dorsal rays are separate for nearly their whole extent, the externo-dorsal rays springing from the individual dorsal rays. The lateral rays turn ventrally. The spicules are stout. There is no accessory piece.

Female: The vulva lies near the middle of the body. The uteri are divergent, furnished with strong ovejectors.

Type-species, *Bathmostomum sangeri*.

BATHMOSTOMUM SANGERI Cobbold, 1879.

*Dochmius sangeri* Cobbold, 1879.

*Uncinaria sangeri* Railliet, 1896 (not Alessandrini, 1905).

*Uncinaria os-papillatum* Piana & Stazzi, 1900.

*Bathmostomum sangeri* Raill. & Henry, 1909.

The oral cavity is wider than long. There are two sub-ventral teeth. The male is 15–16 mm. long and the female is 20 mm. long. The spicules 0.47 mm. in length. Vulva lies near the middle of the body.

*Habitat.* Cæcum of Indian elephant (India).

## Genus BUNOSTOMUM Raill., 1902.

Capsuled bursate nematodes having the mouth guarded by ventral semilunes. The dorsal and externo-dorsal rays are asymmetrical. The mouth cavity contains a dorsal tooth, being the freely projecting ducts of the dorsal œsophageal gland. There is a pair of sub-ventral lancets at its base.

BUNOSTOMUM FOLIATUM Cobbold, 1882.

*Strongylus foliatus* Cobbold, 1882.

*Uncinaria sangeri* Alessandrini, 1905 (not Railliet, 1896).

*Bunostomum foliatum* Raill., Henry & Bauche, 1914.

This nematode was imperfectly described by Cobbold in 1879, and has never been recorded since. Its inclusion in the genus *Bunostomum* is regarded by Railliet as a provisional matter. Probably it will prove to be a representative of a new genus.

TABLE III.—Systematic position of all Nematode Parasites recorded from the Elephant.

Family.	Genus.	Species in Indian Elephant.	Species in African Elephant.
ATRACTIDÆ Travasso, 1919.	LEPEREXIA Khalil, 1922.	<i>L. galabi</i> Khalil, 1922.	<i>L. leiperi</i> Khalil, 1922.
ASCARIDÆ Cobbold, 1864.	BELASCARIS Leiper, 1907.	<i>B. lonchoptera</i> Diesing, 1851.	
SPHURIDÆ Oerley, 1885.	PARABRONEMA Baylis, 1921.	<i>P. indicum</i> Baylis, 1921. <i>P. smithii</i> Cobbold, 1882.	<i>P. africana</i> Baylis, 1921.
	MURSHIDIA Lane, 1914.	<i>M. marshida</i> Lane, 1914. <i>M. falcifera</i> Cobbold, 1882.	<i>M. hadia</i> Khalil, 1922. <i>M. tinstowi</i> sp. n.
	QUILONIA Lane, 1914.	<i>Q. renniei</i> R., Henry & Joy, 1913. <i>Q. travancra</i> Lane, 1914.	<i>Q. apfensis</i> Geelcoest, 1916. <i>Q. africana</i> Lane, 1921. <i>Q. aganda</i> Khalil, 1922. <i>Q. brevicauda</i> , sp. n. <i>Q. ethiopica</i> , sp. n.
STRONGYLIDÆ Cobbold, 1864.	PTERIDOPHARYNX Lane, 1921.	.....	<i>P. africana</i> Lane, 1921. <i>P. auisa</i> Khalil, 1922.
	MEMPHISIA Khalil, 1922.	.....	<i>M. memphisia</i> Khalil, 1922. <i>M. aziza</i> Khalil, 1922.
	AMIRA Lane, 1914.	<i>A. pileata</i> Rail, H. & Bauche, 1914.	<i>A. sameera</i> , sp. n.
	DECRUSIA Lane, 1914.	<i>Decrusia additicia</i> R., H. & B., 1914.	
	EQUINURHA Lane, 1914.	<i>E. sipunculiformis</i> Baird, 1859.	
	CHONLANGIUM R., H. & B., 1914.	<i>C. epistomum</i> Piana & Stazzi, 1900.	
ANCYLOSTOMIDÆ Looss, 1911.	GRAMMOCEPHALUS R. & H., 1910.	<i>G. veredatus</i> Lane, 1921.	<i>G. elathratus</i> Baird, 1868.
	BATHMOSTOMUM R. & H., 1909.	<i>B. sangeri</i> Cobbold, 1879.	
	BUNOSTOMUM Rail, 1902.	<i>B. foliatum</i> Cobbold, 1882.	

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ADDENDUM.

Since the manuscript was sent to the press, a paper by Gedoelst, entitled "Quelques nématodes parasites de l'Éléphant africain,"\* has come to hand. The author describes a new species, *Ascaridia rodhaini* Gedoelst, 1922, from the African elephant. He also records a single female, *Amira pileata*, from the same host. It is very probable that the latter is the female of *Amira sameera*, sp. n., described above. The author redescribes *Murshidia recta* von Linstow, which is renamed above *M. linstowi*, sp. n. Unfortunately, however, Gedoelst's paper is devoid of illustrations.

\* Bull. Soc. Path. Exot. t. xv. Séance, 8 Févr., 1922, No. 2.